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Thermal Energy Supply Optimization for Edgewood Area, U.S. Army Aberdeen Proving Ground

Energy Supply Alternatives

by
Travis L. McCammon, Christopher L. Dilks, and Martin J. Savoie

Relatively poor performance at the aging central heating plants (CHPs) and planned changes in steam demand at Aberdeen Proving Ground (APG) Edgewood Area, Aberdeen, MD warranted an investigation of alternatives for providing thermal energy to the installation. This study: (1) evaluated the condition of the APG CHPs and heat distribution system, (2) identified thermal energy supply problems and cost-effective technologies to maintain APG's capability to produce and distribute the needed thermal energy, and (3) recommended renovation and modernization projects for the system. Heating loads were analyzed using computer simulations, and life cycle costs were developed for each alternative. Recommended alternatives included upgrading the existing system, installing new boilers, consolidating the central heating plants, and introducing the use of absorption chilling.

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Relatively poor performance at the aging central heating plants (CHPs) and planned changes in steam demand at Aberdeen Proving Ground (APG) Edgewood Area, Aberdeen, MD warranted an investigation of alternatives for providing thermal energy to the installation. This study: (1) evaluated the condition of the APG CHPs and heat distribution system, (2) identified thermal energy supply problems and cost-effective technologies to maintain APG's capability to produce and distribute the needed thermal energy, and (3) recommended renovation and modernization projects for the system. Heating loads were analyzed using computer simulations, and life cycle costs were developed for each alternative. Recommended alternatives included upgrading the existing system, installing new boilers, consolidating the central heating plants, and introducing the use of absorption chilling.

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Foreword

This study was conducted for the Aberdeen Proving Ground under Military Interdepartmental Purchase Request (MIPR) No. 93-10. The technical monitor was Shehreyar Husain, APGSA/STEAP-FE-PE.

The work was performed by the Utilities Division (UL-U) of the Utilities and Industrial Operations Laboratory (UL), U.S. Army Construction Engineering Research Laboratories (USACERL). Martin J. Savoie was the USACERL principal investigator. Martin J. Savoie is Chief, CECER-UL-U, John T. Bandy is Operations Chief, and Gary W. Schanche is Chief, CECER-UL. The USACERL technical editor was William J. Wolfe, Technical Resources.

COL James T. Scott is Commander and Acting Director of USACERL, and Dr. Michael J. O'Connor is Technical Director.

Contents

List of Figures and Tables

Figures

Tables

1 Introduction

Background

The main heating system at Aberdeen Proving Ground (APG), Edgewood Area (EA), Aberdeen, MD consists of four base-operated central heating plants (CHPs) and a publicly owned and operated waste-to-energy plant (WEP). Two of the CHPs (E5126 and E3312) are connected to the WEP distribution line. The remaining CHPs (E4160 and E4225) are standalone plants that receive no steam from the WEP.

APG uses steam mainly for heating and domestic hot water purposes, but also has some process use in the E5000 and E3000 areas, e.g., a phosphorus production plant and various chemical weapons research facilities. Steam is also used for air conditioning reheat.

The aging steam distribution system at APG loses a significant amount of energy through condensate leaks and poor insulation on some steam lines. Some of the boilers have reached the end of their useful life and much of the equipment needs an upgrade. For these reasons, APG tasked the U.S. Army Construction Engineering Research Laboratories (USACERL) to evaluate the condition of APG's heating and distribution network, and to investigate feasible opportunities to modernize the system.

Objectives

The objectives of this study were to evaluate the condition of the APG CHPs and heat distribution system, identify any thermal energy supply problems, identify cost effective technologies to maintain APG's capability to produce and distribute the needed thermal energy, and to prioritize renovation and modernization projects for the system.

Approach

Information available from past studies and operation records was analyzed and verified to establish baseline conditions. Central heating plant equipment and the steam distribution system were visually inspected to assess baseline operating conditions and problem areas.

Next, the energy use patterns of APG were analyzed, including current thermal and electrical energy demand, and heating load and cooling load usage patterns. Future energy use for the facility was projected by a variety of prediction methods depending on the specific energy pattern being investigated. Based on the projected energy use patterns, potential thermal energy supply options were identified. These options were evaluated for cost, efficiency, and reliability.

From this information, life-cycle cost analyses were developed for maintaining the status quo, upgrading the system by renewing the existing technology, or by changing to a new technology—absorption chilling. Detailed conceptual analyses were used to determine the most cost-effective alternatives.

Metric Conversion Factors

Metric conversion factors for the U.S. standard units of measure used in this report are given below:

1 cu ft	=	0.028 m^3
1 in	=	25.4 mm
1 ft	=	0.305 m
1 gal	=	3.78 L
1 lb	=	0.453 kg
1 psi	=	6.89 kPa
°F	=	(°C x 1.8) + 32
1 Btu	=	2.928×10^{-4} kilowatt hr

2 Existing Steam Supply Systems

Central Heating Plants

APG EA has four major CHPs that service the main distribution networks:

1. CHP E5126, which is the main heating central plant. All boiler operators and maintenance personnel are stationed at this plant, with the exception of one operator stationed at E3312. E5126 supplies steam for the E5000 area. With new boilers and closing of the steam loop, three more areas could be included to back up WEP steam: (a) E-4400/E-4200 block, (b) the new Life Science Building, and (c) the future AEHA complex.

2. CHP E3312, which is connected to CHP E5126 the WEP steam lines.

3. CHP E4160, which is an independent plant. This plant is also connected to the WEP line (both steam and condensate). E-4160 has three Cleaver-Brook boilers (No. 1–250 HP; No. 2–350 HP; No.3–300 HP) to operate when needed because WTE is the primary source.

4. CHP E4225, which is also an independent plants.

All boilers are rated at 100 psig. WTE is reduced to 100 psig at E-4160, and is further reduces near buildings and at E-4225 (at E-4225, to 40 psig; in a manhole near E-4225, to about 22 psig). After completion of a new piping system, the old system will be abandoned in place.

CHP E5126 contains six watertube boilers. Boilers 1 to 5, starting at the south end of the building, are watertube boilers, originally designed to burn coal, which were installed in 1941 and are each rated at 25,000 lb/hr steam at 200 psig, 381 °F. Boilers 1 to 5 have since been converted to burn No. 2 oil. Combustion controls for these boilers do not work. Boiler operators manually adjust the air-to-fuel ratios on the stationary boilers by visually inspecting the burner flame to achieve a proper mixture. Also, these boilers have no flame safe or purge controls. As a result, inefficient and hazardous conditions are likely.

Boiler No. 6 is a package watertube boiler installed in 1987, with a rating of 31,254 lb/hr at 260 psig, 404 °F. This boiler has adequate combustion controls and is in very good condition.

CHP E3312 contains five package boilers and supplies steam for the E3000 area. This plant is manned by one operator who reports to the main plant every hour.

Boilers No. 1, 2, and 5 at E3312 are fire tube boilers designed to burn No. 2 oil. They were installed in 1988 and are each rated at 33.476 MBtu/hr. They have a design pressure of 150 psig and currently operate at 125 psig.

Boilers No. 3 and 4 are also firetube boilers that burn No. 2 oil. Both were installed in 1975 and each is rated at 29.291 MBtu/hr. They have a design pressure of 150 psig and operate at 125 psig.

CHP E4160, which is not interconnected with any other plants, contains three firetube boilers. The first boiler is rated at 8.369 MBtu/hr and the second boiler at 10.043 MBtu/hr. Both boilers can operate at 150 psig; however, they normally operate at 22 psig. Their main purpose is to supply steam for heating and domestic hot water to the E4100 and E4400 areas, which are comprised of barracks and administration buildings.

The E4200 area is serviced by CHP E4225. This plant contains three firetube boilers, each rated at 8.56 MBtu/hr and 125 psig allowable pressure. This plant is not connected to any other plant and its main user is the dinning hall located in E4225. It also supplies steam for heat and domestic hot water to a small number of users.

The WEP is comprised of four 90-ton per day (TPD) CONSUMAT incinerator systems along with three ABCO watertube boilers and two electrostatic precipitators. This plant supplies steam at 350 psig to the E5000 and E3000 areas of APG. Table 1* summarizes the design data for the boilers in the APG heating plants.

Steam Distribution System

The APG steam distribution network is comprised of four distribution systems. Figure 1 shows the layout of the entire distribution network. The four main areas are the E5000, E3000, E4100, and E4200 areas. The E5000 (Figures 2 and 3) and E3000 (Figure 4) areas are interconnected through the WEP steam lines. Steam is piped into

* Tables and figures appear at the end of the chapters.

CHPs E5126 and E3312 from the WEP at 350 psig and reduced to 125 psig. The steam is then sent out through the local networks. The E4100 and E4200 areas do not receive steam from the WEP. Their steam is supplied from their local heating plants. (Note that the illustration for areas E4100 and E4200 is given in Chapter 6 [p 55]. Since this study, the steam lines have been connected to the WEP, and the system loop has been completed.)

The steam lines in the E5000 and E3000 areas are mostly aboveground lines supported by metal or wooden stanchions; however there also are some underground sections. The aboveground steam lines are in fair condition, but portions of the insulation on these lines are badly degraded and some sections are completely missing insulation, which leads to excessive heat loss through pipe walls.

Condensate is returned in both the E3000 and E5000 areas. Currently APG returns 48 percent of its condensate to the WEP. APG receives a credit on its steam bill for this returned condensate when it reaches a 50-percent return level. However, the condensate lines in the E3000 area are in poor condition, have many leaks, and in some areas have been abandoned.

The steam lines in the E4400 and E4200 areas are mostly located underground in a conduit system with manholes for access. The manholes in these areas are in very poor condition. Most manholes do not have sump pumps and the existing drains are clogged with debris. As a result, many manholes have filled with mud. Also, water can be seen steaming in some of the manholes, reducing the remaining life of the steam and condensate lines in these areas.

Boilers at E-5126 are being designed for replacement. Old boilers No. 1, 2, and 3 will be demolished and replaced by two, 2000 HP, 350 psig steam boilers to generate approximately 60,000 lb/hr of steam. This pressure is compatible with WEP steam pressure and will help in using the WEP steam line if and when WEP breaks down. Boiler No. 6 will remain "as is." Boilers No. 4 and 5 will be abandoned before construction is completed. The steam distribution system in 5000 Area will not change.

Table 1. Edgewood Arsenal boiler design data.

Building	Boiler	Manufacturer	Year Built	Type	Capacity	Fuel
E5126	1, 2	Edgemoor	1941	Watertube	25,000 lb/hr, 200 psig (allowable pressure)	No. 2 oil
E5126	3, 4, 5	Union Iron Works	1941	Watertube	25,000 lb/hr, 200 psig	No. 2 oil
E5125	6	Cleaver brooks	1985	Package, Watertube, NB# 59888	31,254 lb/hr, 200 psig	No. 2 oil
E3312	1, 2, 5	Cleaver Brooks	1988	Package, Firetube	33.475 MBtu/hr	No. 2 oil
E3312	3, 4	Cleaver Brooks	1975	Package, Firetube	29.291 MBtu/hr	No. 2 oil
E4160	1, 2, 3	Cleaver Brooks	1978	Package, Firetube	10.043 MBtu/hr	No. 2 oil
E4225	1, 2, 3	Titusville	1961	Firetube	8.56 MBtu/hr	No. 2 oil
WEP		ABCO	1988	Watertube	1741 klb/day (360 t/day maximum)	Municipal waste

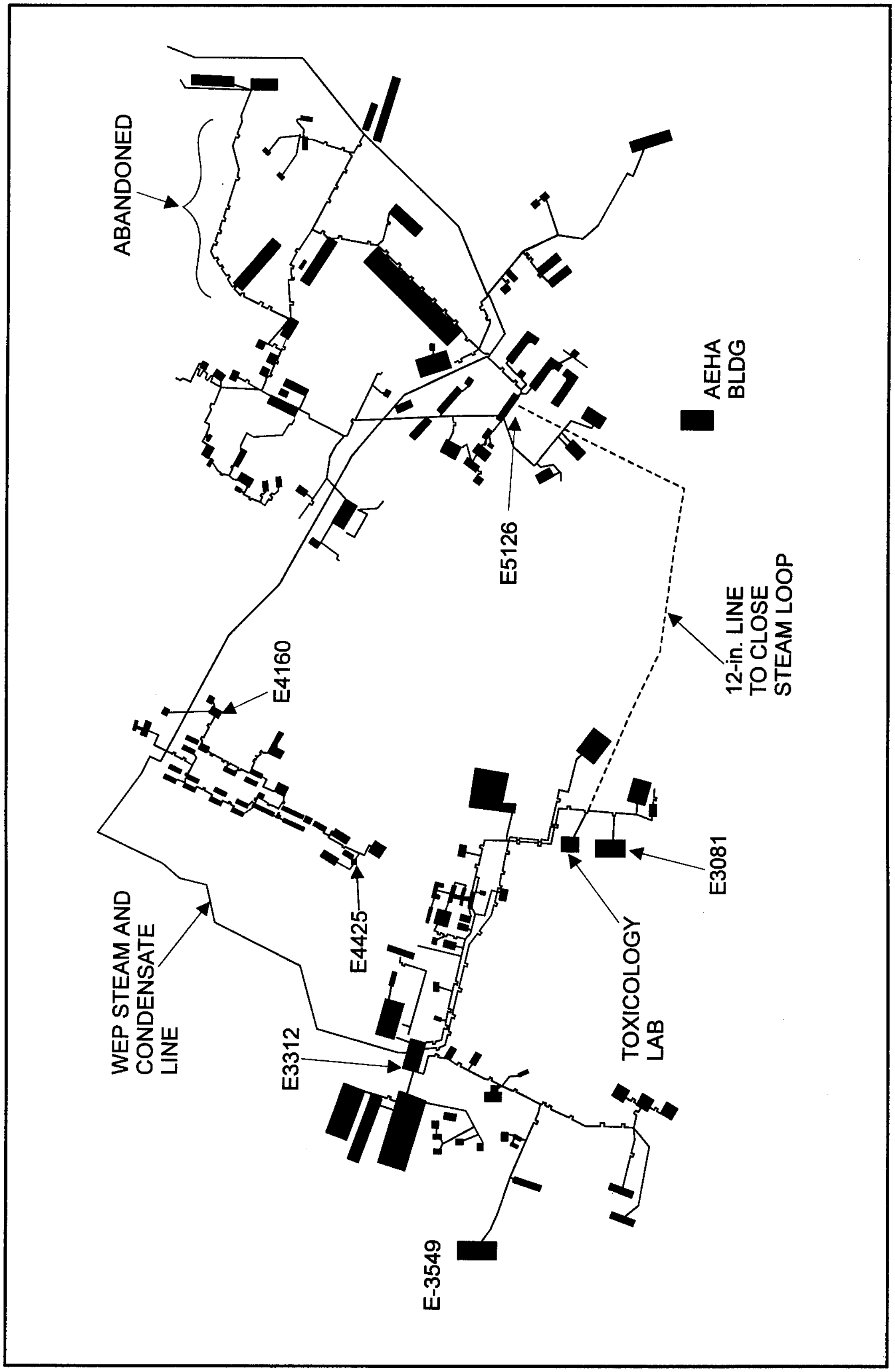

Figure 1. APG steam distribution network (entire).

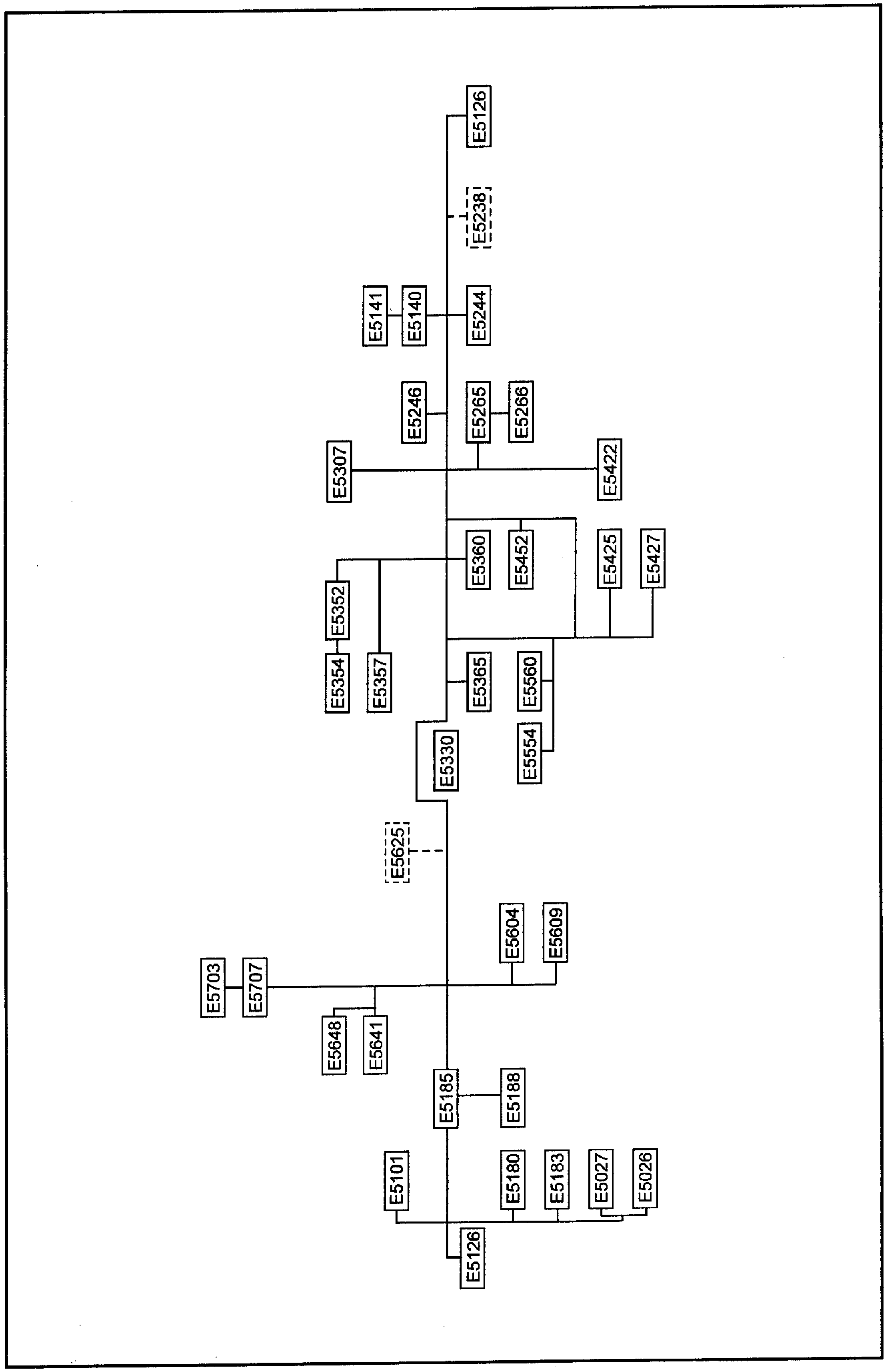

Figure 2. APG steam distribution network (area E5000).

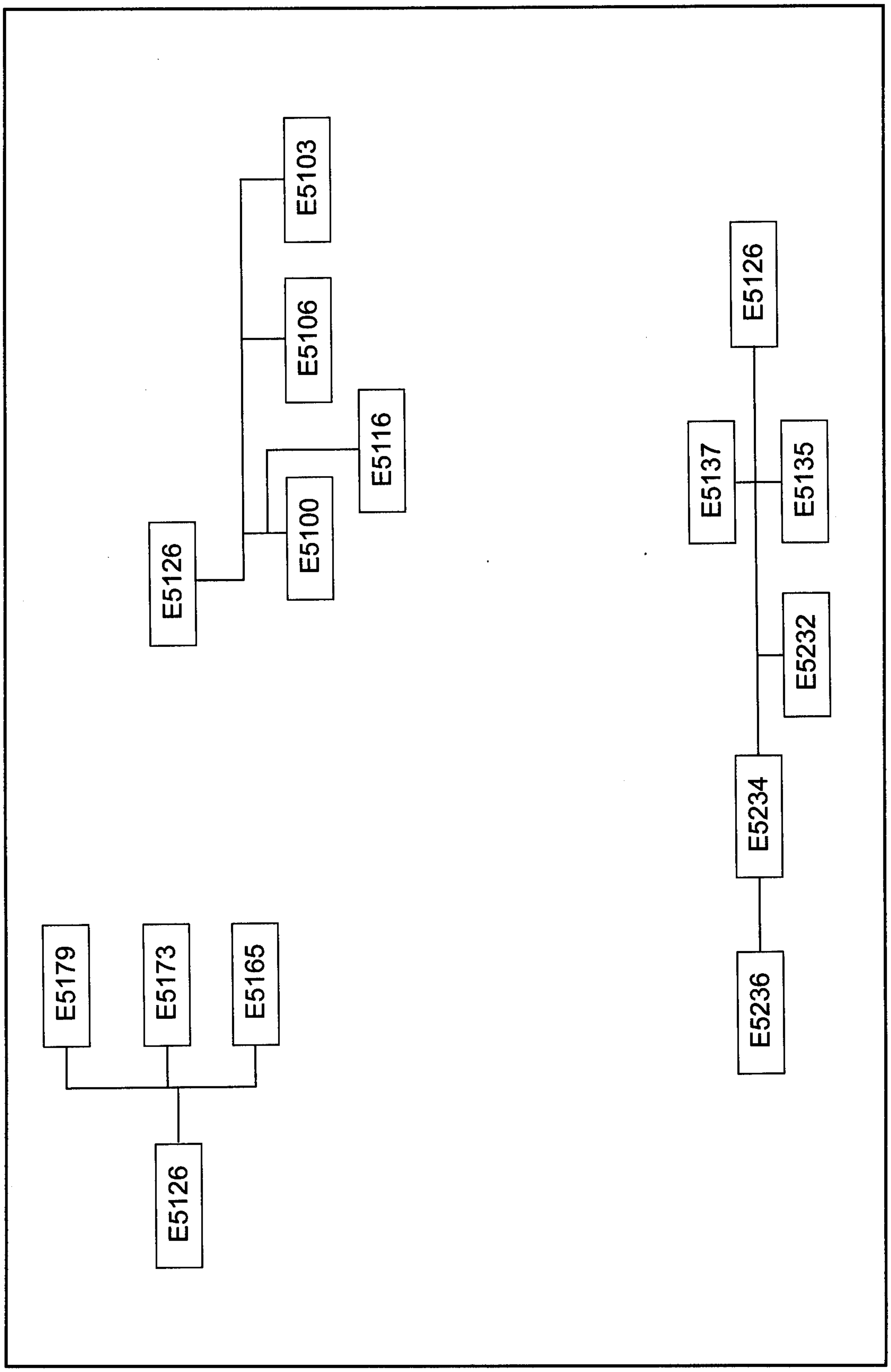

Figure 3. APG steam distribution network (area E5000–detail).

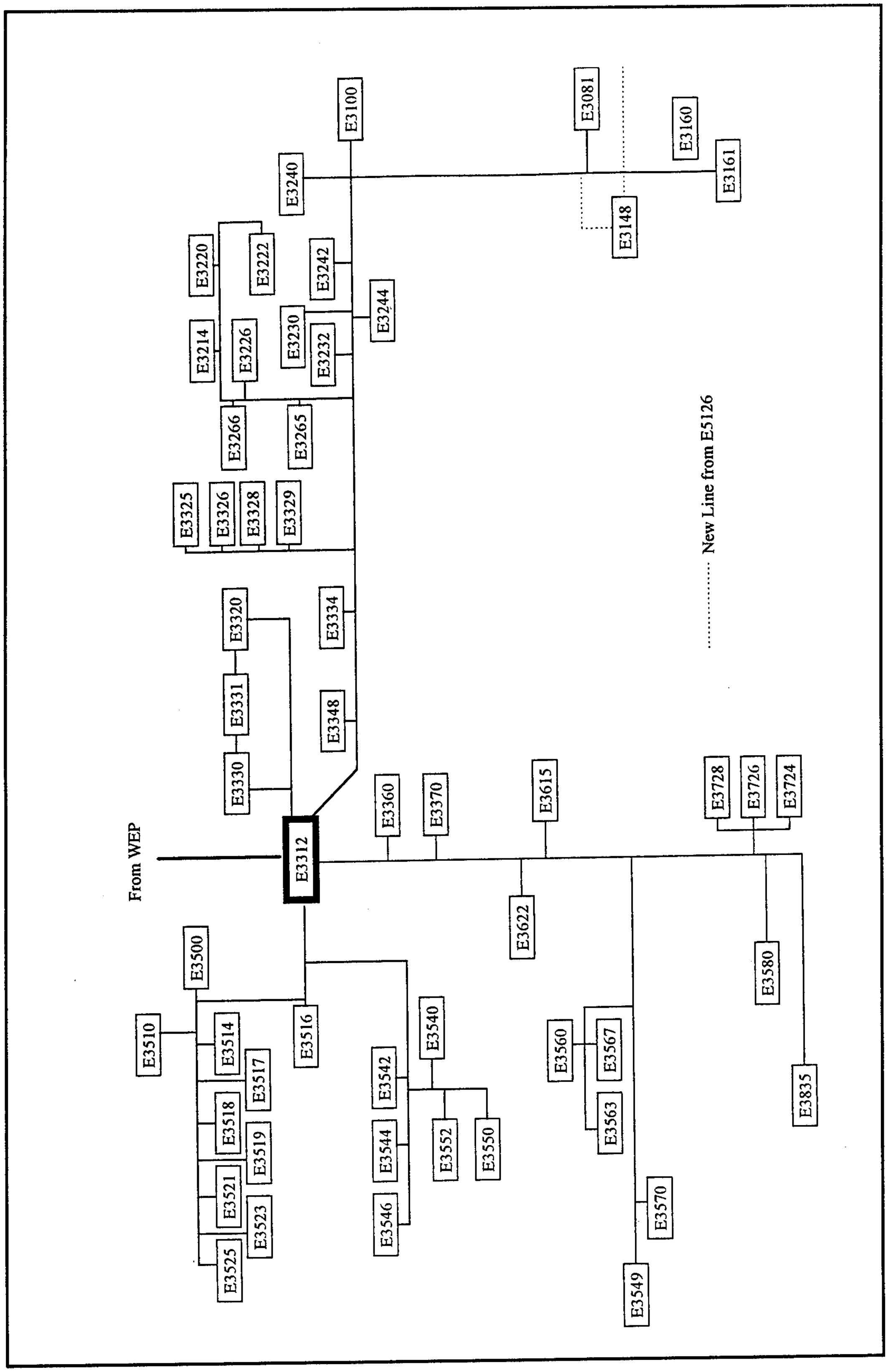

Figure 4. APG steam distribution network (area E3000).

3 Thermal Energy Supply and Consumption

This chapter describes current thermal energy supply and use. Central heating plant steam output and fuel use were analyzed for trends, and building heating loads and distribution systems losses were modeled. This section also develops correlations between thermal energy use and heating degree days (HDD) for use in load prediction.

Central Heating Plant Steam Load

CHP personnel collected system data on DA Form 3995, Daily Boiler Plant Operating Log. The boiler log contains hourly and shift information on many important operating parameters. The hourly steam flow readings were the primary source to estimate peak steam usage because of the detail available. To reduce the amount of data to a manageable size, hourly records were summed to acquire daily totals. However, these logs were only kept for CHPs E3312 and E5126. Fuel delivery logs were used to estimate steam production at CHPs E4160 and E4225, assuming a boiler efficiency of 75 percent.

The baseline year selected for thermal energy consumption was from October 1990 to September 1991, the most current time period with complete and available records. No unusual activities were identified that might skew projections of energy consumption. Figure 5 shows the daily steam demand for this time period for E5126. This graph includes both the steam purchased from the WEP and the steam produced at E5126. The highest steam demand recorded was about 93 MBtu/hr in January. The summer demand averages about 11 MBtu/hr with peaks of about 15 MBtu/hr. Table 2 shows the total steam flow and average hourly steam flow on a monthly basis for this time period.

Figure 6 shows the average daily steam demand at CHP E3312 for the baseline year. This graph also includes both WEP steam and E3312 steam. The highest steam demand recorded peaked at 65 MBtu/hr in late January. The summer demand in this area is very high with an average of about 28 MBtu/hr. This high demand is probably due to large chemical processing loads, the use of steam for air conditioning reheat, and leaks. Table 3 shows the total steam flow and average hourly steam flow on a monthly basis for the baseline year.

Boiler logs were not available for CHPs E4160 and E4225. Instead, monthly oil deliveries were analyzed to determine a baseline steam profile for these two plants. The time from October 1989 through December of 1991 was selected for analysis because it offered the most complete data.

Figure 7 shows the estimated monthly steam demand for CHP E4160 during the baseline time period. The 100 percent efficiency curve demonstrates the amount of energy available in the fuel oil consumed. The assumption was made that the boilers at E4160 were about 75 percent efficient. The 75 percent efficiency curve represents the amount of energy contained in the fuel that is actually converted to steam. To determine the energy content available in the fuel oil, the conversion factor of 139,400 Btu/gal of No. 2 fuel oil was used.

The highest average hourly steam flow occurs in January of 1991 at about 11 MBtu/hr; the average hourly flow during the summer is around 1 MBtu/hr.

Figure 8 shows the estimated monthly steam demand for CHP E4225 for the baseline period. Once again, the 100 percent efficiency curve represents the energy available in the fuel while the 75 percent efficiency curve represents the portion of this energy converted to steam. This plant also uses No. 2 fuel oil.

For E4225, the highest average hourly flow during the baseline period is 4.2 MBtu/hr in January of 1991. The average summer steam flow is at 1 MBtu/hr.

Tables 4 and 5 give the monthly oil deliveries for CHPs E4160 and E4225 respectively, during the baseline period. These tables also show the corresponding amount of energy in the fuel that is converted to steam, assuming a 75 percent boiler efficiency. Data is presented in both MBtu and pounds of steam. To calculate the values in lb/hr, the conversion factor of 1168.09 Btu/lb (22 psig saturated steam) was used. The boilers in CHP E4225 operate at 125 psi gauge or 140 psi absolute at saturation.

Steam End-Use

CHP output is a good indicator of current thermal energy use; however, individual building and process loads must also be estimated to analyze alternatives that would shift loads from one plant to another, or that would remove the load entirely. Some typical changes might be building demolitions and renovations.

There are currently no operating steam submeters to measure building heating or process loads. End-user loads had to be estimated using modeling techniques (the HEATLOAD program).

HEATLOAD, an (as yet unpublished) software program developed by USACERL, provides a simple method of calculating building heat requirements. Other computer programs such as BLAST or DOE2* can provide more accurate analysis, but require much more information to develop a heat load estimate. Experience with HEATLOAD has shown it to be quite accurate for estimating installation-wide building heat requirements for central energy plant alternatives.

HEATLOAD is based on a series of linear regressions developed from heating use measurements at typical facilities on several Army installations. The facility categories and regressions are listed in Table 6. Each building type has a corresponding daily heating energy consumption equation in the form of $E_h = a_1 + (b_1 \times HDD_d)$, where a_1 and b_1 are regression parameters. The symbol "E_h" is the daily heating energy consumption (Btu/sq ft/day) and HDD_d is the daily heating degree day.

The regression parameter a_1 is a constant that represents energy usage that occurs for zero HDD and reflects nonheating loads such as hot water and cooking. The regression parameter b_1 is the heating load parameter. Building categories and area (sq ft) were obtained from the Building Information Schedule for APG.

The climatological data required for HEATLOAD, such as the historical average HDD and the design temperature, is obtained from the Army Technical Manual "Engineering Weather Data" (TM 5-785, 1978) or directly from the USAF Environmental Technical Applications Center (ETAC) at Scott AFB, IL. With this information, HEATLOAD will calculate the peak hourly heating load, average monthly loads, maximum monthly loads, and total annual heating load.

Heating load estimates

Tables 7 and 8 show the total monthly building heat loads estimated by HEATLOAD for each CHP system. The building loads were estimated based on baseline heating degree days and summed for each month. Figures 9 through 12 show these loads with the corresponding CHP output either (1) based on 75 percent of fuel consumption, which is equivalent to 75 percent boiler efficiency, or (2) based on the recorded steam

* *Evaluation of Five Additional Enhancements to the Building Loads Analysis and System Thermodynamics (BLAST) Program*, Technical Report (TR) FE-93/18/ADA267999 (U.S. Army Construction Engineering Research Laboratories [USACERL], April 1993); Don A. York, Eva A. Tucker, and Charlene C. Cappiello, *DOE-2 Reference Manual (Version 2.1A)* (Los Alamos National Laboratory, Los Alamos, NM, May 1981).

flow. It is important to note that HEATLOAD does not account for distribution losses, which are estimated in the following section. Appendix A gives detailed building heatload information.

Distribution system losses

A steam distribution system typically consists of steam generators, pipes, regulators, valves, and traps. Steam enters the system at the steam plant, passes through pipes, valves, and regulators, and is delivered to the buildings. The steam loses heat through pipe walls by conduction. As the steam passes through the pipes, regulators, and valves, steam pressure drops. Condensate formed in the pipes is removed from the system through steam traps and a condensate piping system. The amount of energy lost from the steam distribution system can be substantial.

One way of estimating the distribution losses is to look at the lowest hourly steam flow during the summer months. This technique only works if there are no substantial summer steam loads. Figures 2 through 5 show the lowest steam demand and the corresponding steam losses to be about 1 MBtu/hr for E4160 and 1 MBtu/hr for E4225.

Figure 2 shows a sudden change in steam demand at CHP E5126 in both November and May. This is attributed to the fact that part of the E5000 area distribution network is shut down in the summer. Just before the partial shutdown, the steam rate is about 34 MBtu/hr, which represents the sum of the losses and process loads when the entire system is on. After the shutdown, the load drops to 10 MBtu/hr. This value represents the summer process load and loss.

This method will not work for E3312 because there is significant summer loads in this area. Determining the lowest summer load by analyzing steam load data is a good, but not very rigorous, method to estimate distribution losses. To better quantify these losses, this study used a computer model called the Steam Heat Distribution Program (SHDP) to analyze distribution system losses.*

SHDP Analysis

SHDP is a pressure-flow-thermal efficiency computer program for modeling steam district heating systems. The program has several capabilities including: (1) design and economic evaluation of manhole renovation and modifications or additions to

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* James A. Miller and David M. Wasserman, *Steam Heat Distribution Program User's Manual*, Technical Memorandum (TM) No. M-73-89-01CR (Naval Civil Engineering Laboratory, Port Hueneme, CA, August 1989).

existing distribution systems, and (2) economic evaluation of operating at lower pressures and improved maintenance of steam traps. In this study, SHDP was primarily used to estimate distribution losses and to determine proper pipe sizes for new piping.

To use SHDP, the entire APG steam distribution system was mapped (Figure 1). SHDP is designed to estimate the total heat load to the heating plant with a breakdown of the distribution losses. This requires entering distribution line nodes, line diameters and lengths, CHP supply pressure, and individual building loads. Nodes are locations of pipe size changes, pressure reducing valves and thermal loads (typically buildings). Pipe diameters and lengths were obtained from blueprints of the APG distribution system. As described in the previous section, the thermal loads for each building were estimated using the HEATLOAD program. Table 9 lists the basic assumptions made in creating the distribution model for APG. Steam trap leakage rates were set to zero because most losses stem from the condensate.

The SHDP model was run using unconstrained pressure throughout the system to determine if adequate pressure was available to each building. The results indicated that the current boiler pressures of 125 psig at CHPs E5126, E3312, and E4225 and 22 psig at CHP E4160 was adequate to meet the current loads. This analysis indicated that the distribution system can easily provide the required pressure at all buildings. Appendix B contains SHDP results for each CHP system at the temperature of 0 °F (65 HDD).

Table 10 lists the distribution losses estimated by SHDP for the baseline period for CHPs E5126 and E3312. The distribution loss when part of the E5000 area is shut down for CHP E5126 is about 2.1 MBtu/hr, which means there should be approximately 7.4 MBtu/hr of unaccounted process use in this area. However, when the entire E5000 area is on, SHDP predicts losses of 32 MBtu/hr. This is largely due to poor insulation of piping, which results in excessive heat conduction through the pipe walls. SHDP predicted the losses at CHP E3312 to be 14.4 MBtu/hr.

Table 11 lists the SHDP estimated baseline distribution losses for CHPs E4160 and E4225. The summer distribution loss is about 1.8 MBtu/hr for E4160, which is fairly close to the value of 1 MBtu/hr shown in Figure 4. The loss for E4225 is about 0.5 MBtu/hr, which is in line with the value of 1 MBtu/hr shown in Figure 5.

These losses were added to the HEATLOAD monthly estimates to obtain a total monthly steam demand on the CHP. Figures 13 through 16 show actual CHP energy data for the heating loads with the losses included. Figure 13 shows that the predicted losses for E5126 during the summer are fairly low, indicating that there must be approximately 7 MBtu/hr of process load not accounted for in the HEATLOAD values. This process load could be attributed to the phosphorus plant. However, during the heating season, the model is predicting accurately.

Figure 14 shows that the HEATLOAD model for the E3000 area follows the same pattern as the actual data. There is a small gap between the actual data and the model, probably due to the special process loads in the E3000 area.

Figures 15 and 16 show that the model tends to follow well with the actual data for both the E4160 and E4225 CHPs. There are some varying slopes between the model and actual data; however, this is to be expected since the actual energy data is based on fuel oil delivery logs instead of steam production logs.

Heating Load vs HDD Model

Typically, heating loads are very closely related to the outside temperature or heating degree day (HDD). However, a single year is not a good prediction of the steam demand for the 25-year period required for life cycle cost analysis of alternatives unless it is very close to the normal HDD for the region. A correlation developed between steam demand and HDD for 1 year can be used to project the steam demand for the Normal HDD.

Linear regressions were performed on the monthly load profiles for both actual data and modeled data with the corresponding monthly HDD. The results are shown graphically in Figures 17 through 20. These figures show that the difference between the computer models and the regressions performed on actual data is very small. At the extreme weather conditions represented by 60 HDD on the graph, the percent error of the models range from 1 percent for E4160 to 4 percent for E5126 and E3312. E4225 has a percent error of about 3.5 percent.

A HDD model based on actual data was then used along with the Normal HDD to project the long-term steam requirements for each CHP. This data was then used for the baseline energy consumption in the modernization alternatives.

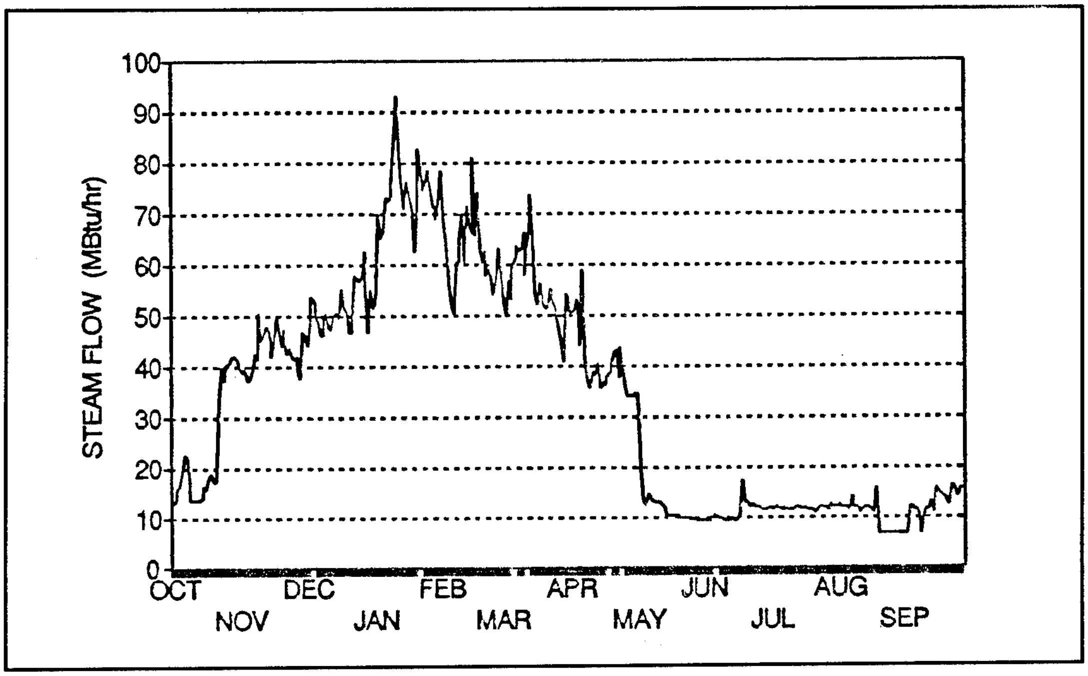

Figure 5. E5126 recorded steam flow.

Table 2. CHP E5126 baseline monthly steam loads.

Month	Total Steam Flow (K lbs)	Average Steam Flow (lbs/hr)	Total Steam Flow (MBtu)	Average Steam Flow (MBtu/hr)
Oct	14,399	19,353	17,178	23.1
Nov	26,045	36,173	31,072	43.2
Dec	31,790	42,728	37,925	51.0
Jan	45,220	60,780	53,948	72.5
Feb	35,590	52,962	42,459	63.2
Mar	34,975	47,010	41,725	56.1
Apr	24,714	34,325	29,484	41.0
May	8,153	10,959	9,727	13.1
Jun	6,731	9,348	8,030	11.2
Jul	7,463	10,031	8,904	12.0
Aug	6,033	8,109	7,198	9.7
Sep	7,119	9,888	8,493	10.6

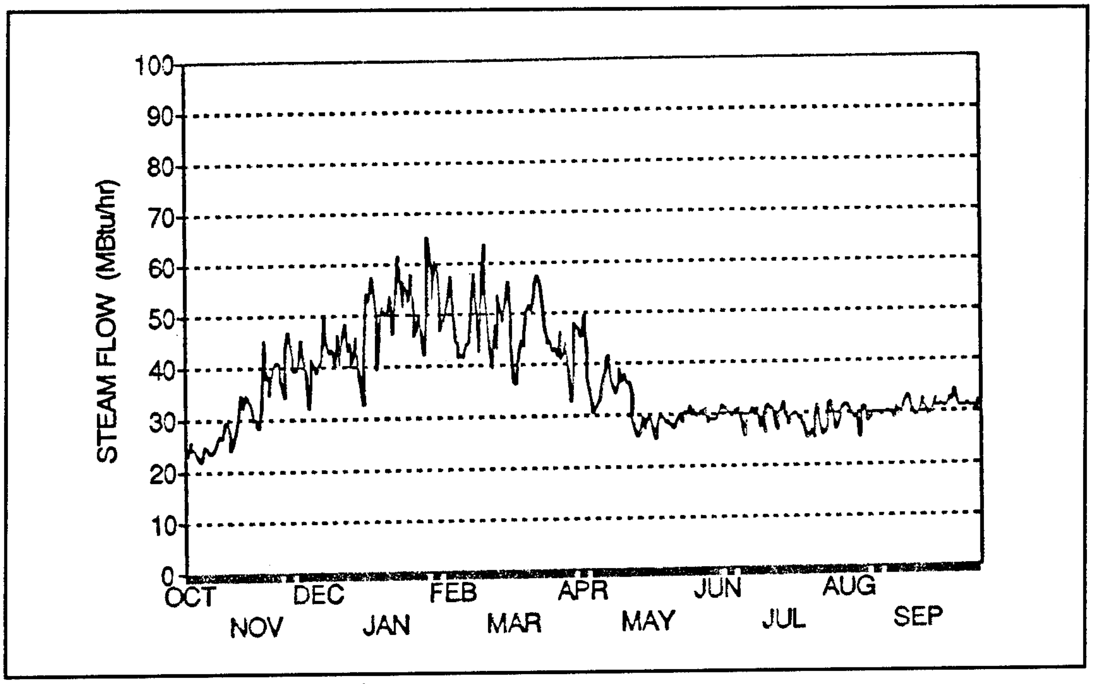

Figure 6. E3312 recorded steam flow.

Table 3. CHP E3312 baseline monthly steam loads.

Month	Total Steam Flow (K lbs)	Average Steam Flow (lbs/hr)	Total Steam Flow (MBtu)	Average Steam Flow (MBtu/hr)
Oct	16,820	22,607	20,066	27.0
Nov	21,545	29,923	25,703	35.7
Dec	27,638	37,147	32,972	44.3
Jan	32,794	44,078	39,123	52.6
Feb	27,752	41,298	33,109	49.3
Mar	28,281	38,012	33,739	45.3
Apr	21,453	29,796	25,593	35.5
May	18,146	24,390	21,648	29.1
Jun	17,973	24,962	21,442	29.8
Jul	17,964	24,145	21,431	28.8
Aug	18,820	25,295	22,452	30.2
Sep	18,965	26,341	22,625	31.4

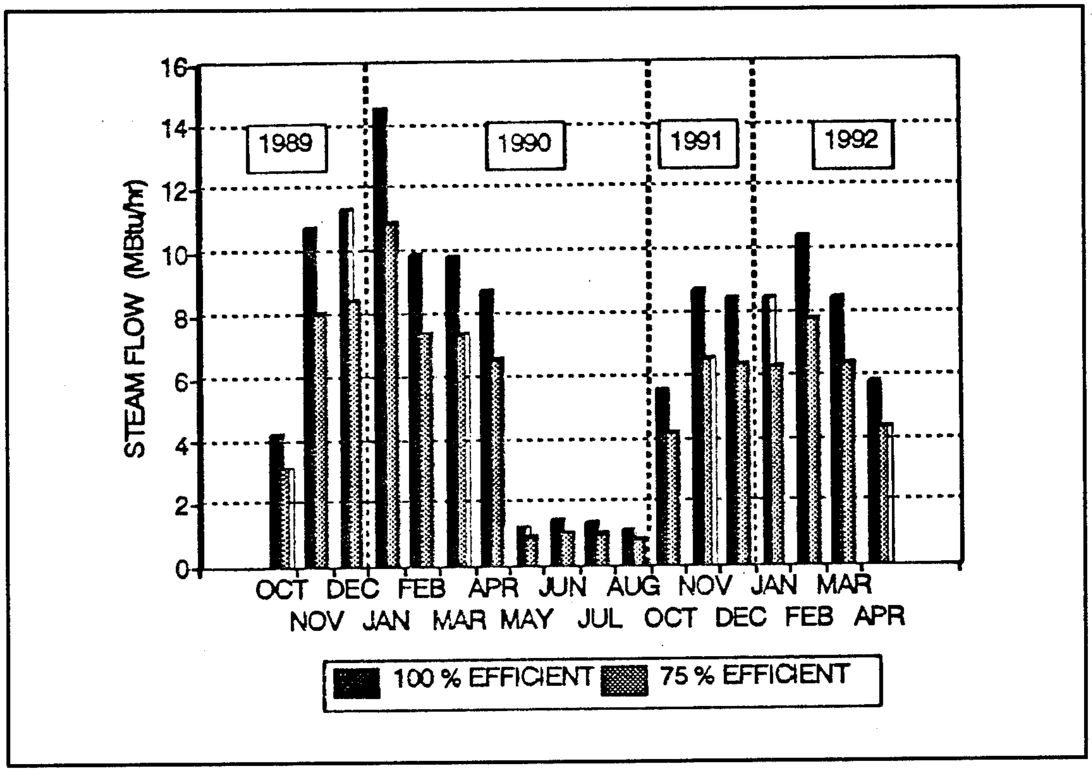

Figure 7. E4160 estimated steam flow.

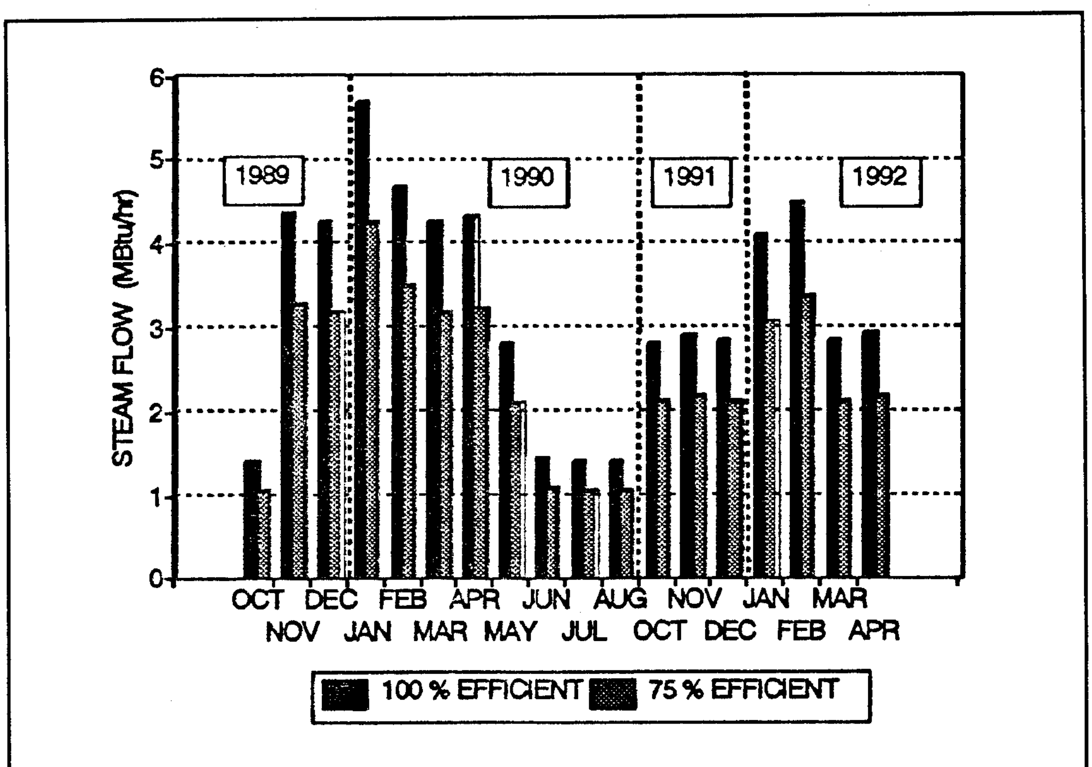

Figure 8. E4225 estimated steam flow.

Table 4. E4160 monthly oil deliveries and steam production.

	Month	No. 2 Fuel Oil (Gallons)	Total Steam Flow 75% Eff. (K lbs)	Average Steam Flow 75% Eff. (lbs/hr)	Total Steam Flow 75% Eff. (MBtu)	Average Steam Flow 75% Eff. (MBtu/hr)
1989	Oct	22,450	2,009	2,701	2,347	3.15
	Nov	55,460	4,964	6,894	5,798	8.05
	Dec	60,567	5,421	7,286	6,332	8.51
1990	Jan	77,790	6,963	9,358	8,133	10.93
	Feb	47,709	4,270	6,354	4,988	7.42
	Mar	52,382	4,688	6,302	5,477	7.36
	Apr	45,221	4,048	5,622	4,728	6.57
	May	6,549	586	788	685	0.92
	Jun	7,442	666	925	778	1.08
	Jul	7,500	671	902	784	1.05
	Aug	5,963	534	717	623	0.84
1991	Oct	29,969	2,682	3,605	3,133	4.21
	Nov	45,113	4,038	5,608	4,717	6.55
	Dec	45,378	4,062	5,459	4,744	6.38

Table 5. E4225 monthly oil deliveries and steam production.

	Month	No. 2 Fuel Oil (Gallons)	Total Steam Flow 75% Eff. (K lbs)	Average Steam Flow 75% Eff. (lbs/hr)	Total Steam Flow 75% Eff. (MBtu)	Average Steam Flow 75% Eff. (MBtu/hr)
1989	Oct	7,471	655	880	781	1.05
	Nov	22,547	1,976	2,744	2,357	3.27
	Dec	22,711	1,990	2,675	2,374	3.19
1990	Jan	30,271	2,653	3,566	3,165	4.25
	Feb	22,446	1,967	2,927	2,347	3.49
	Mar	22,655	1,985	2,669	2,369	3.18
	Apr	22,278	1,952	2,712	2,329	3.23
	May	14,992	1,314	1,766	1,567	2.11
	Jun	7,452	653	907	779	1.08
	Jul	7,430	651	875	777	1.04
	Aug	7,463	654	879	780	1.05
1991	Oct	15,007	1,315	1,768	1,569	2.11
	Nov	15,049	1,319	1,832	1,573	2.19
	Dec	15,116	1,325	1,781	1,580	2.12

Table 6. Building categories and energy consumption equations.

Troop Housing Barracks	$E_h = 130.50 + (10.53 \times HDD_d)$
Troop Housing Barracks (after 1966)	$E_h = 81.91 + (7.40 \times HDD_d)$
Troop Housing Barracks (modular)	$E_h = 295.90 + (10.53 \times HDD_d)$
Dining Facilities	$E_h = 241.90 + 0$
Family Housing	$E_h = 113.5 + (10.53 \times HDD_d)$
Administration/Training	$E_h = 75.71 + (7.02 \times HDD_d)$
Medical/Dental	$E_h = 254.40 + (11.41 \times HDD_d)$
Storage	$E_h = 35.70 + (10.53 \times HDD_d)$
Production/Maintenance	$E_h = 138.25 + (10.53 \times HDD_d)$
Fieldhouses/Gymnasiums	$E_h = 73.69 + (4.39 \times HDD_d)$

Table 7. HEATLOAD predicted monthly steam loads for baseline period, CHP systems E5126 and E3312.

	E5126		E3312	
Month	Total Steam Flow (MBtu)	Average Steam Flow (MBtu/hr)	Total Steam Flow (MBtu)	Average Steam Flow (MBtu/hr)
Oct '90	6,174	8.3	7,092	9.5
Nov	12,087	16.8	12,849	17.8
Dec	17,832	24.0	18,508	24.9
Jan '91	22,579	30.3	23,155	31.1
Feb	17,048	25.4	17,638	26.2
Mar	14,630	19.7	15,372	20.7
Apr	8,286	11.5	9,126	12.7
May	2,949	4.0	3,934	5.3
Jun	1,719	2.4	2,697	3.7
Jul	1,681	2.3	2,693	3.6
Aug	1,681	2.3	2,693	3.6
Sep	2,756	3.8	3,712	5.2

Table 8. HEATLOAD predicted monthly steam loads for baseline period, CHP systems E4160 and E4225.

	--------E4160--------		--------E4225---------	
Month	Total Steam Flow (MBtu)	Average Steam Flow (MBtu/hr)	Total Steam Flow (MBtu)	Average Steam Flow (MBtu/hr)
Oct '89	2,000	2.7	855	1.1
Nov	3,616	5.0	1,388	1.9
Dec	6,858	9.2	2,475	3.3
Jan '90	4,560	6.1	1,709	2.3
Feb	4,081	6.1	1,530	2.3
Mar	3,779	5.1	1,448	1.9
Apr	2,683	3.7	1,077	1.5
May	1,511	2.0	692	0.9
Jun	990	1.4	512	0.7
Jul	1,002	1.3	522	0.7
Aug	997	1.3	521	0.7
OCT '91	2,237	3.0	934	1.3
NOV	3,838	5.3	1,462	2.0
DEC	5,074	6.8	1,880	2.5

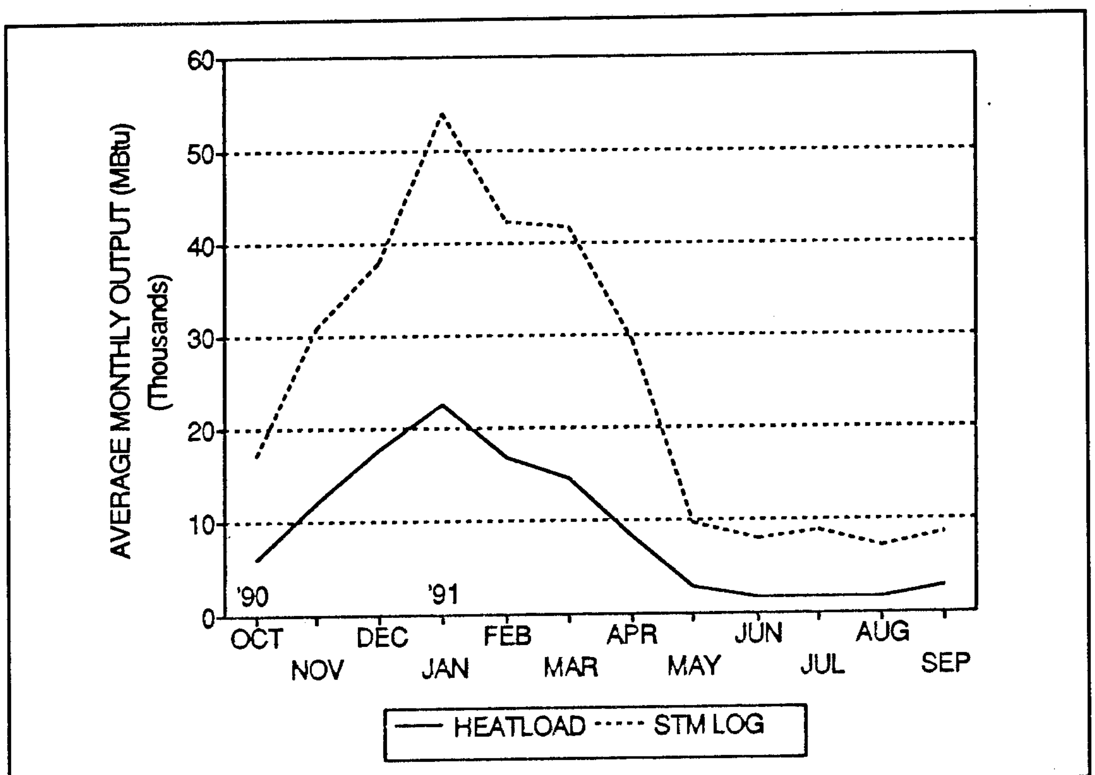

Figure 9. E5126 HEATLOAD predictions.

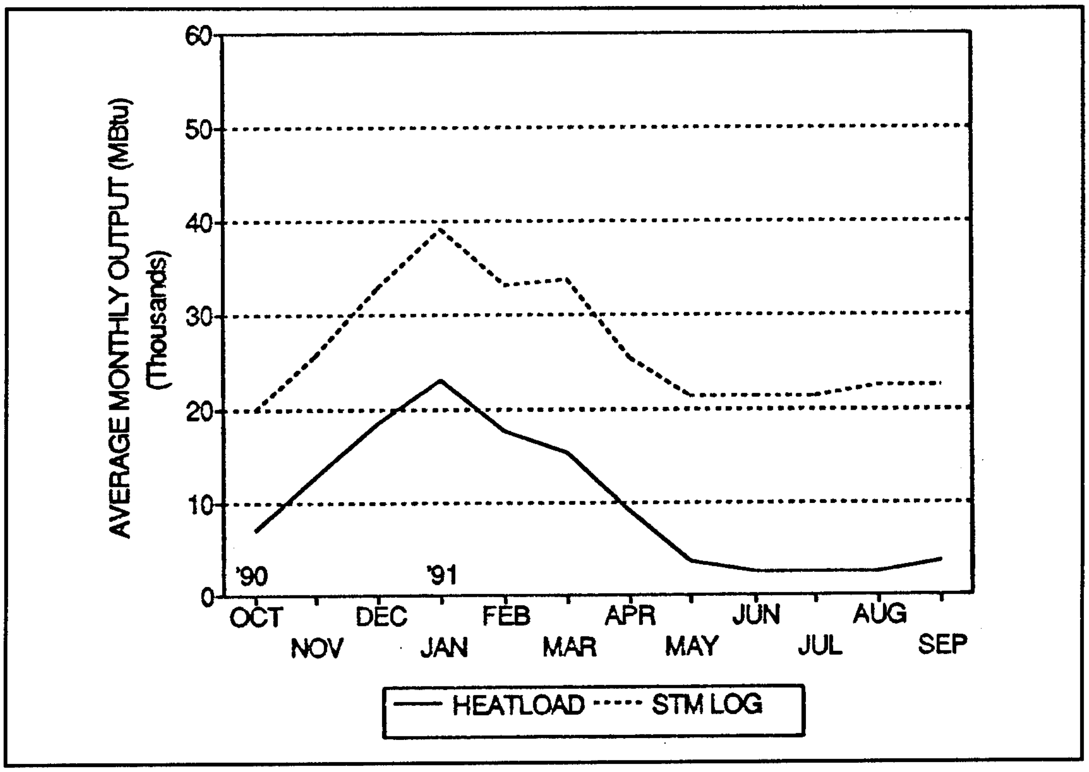

Figure 10. E3312 HEATLOAD predictions.

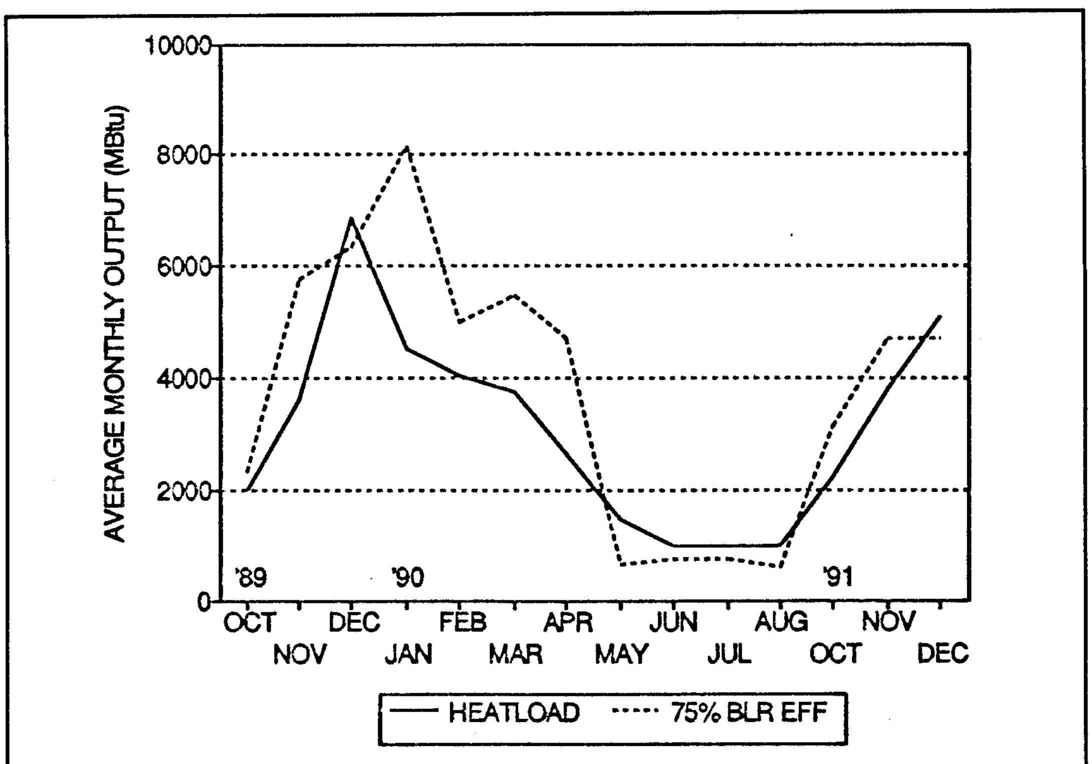

Figure 11. E4160 HEATLOAD predictions.

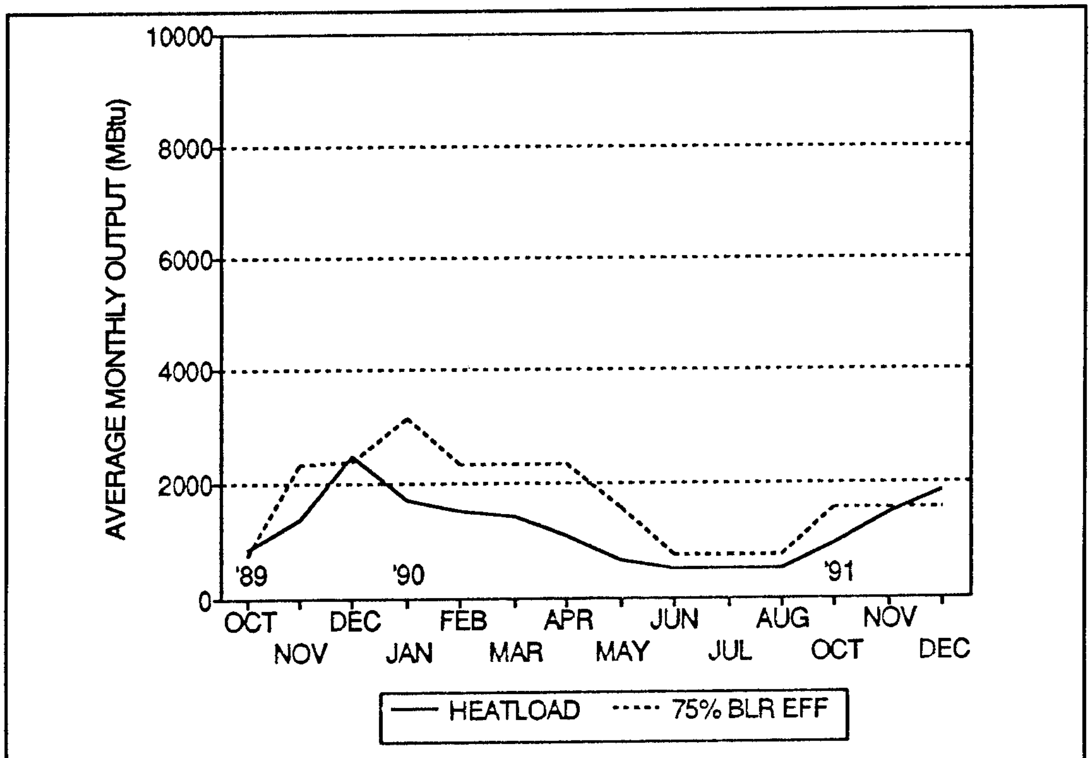

Figure 12. E4225 HEATLOAD predictions.

Table 9. SHDP model assumptions.

Pipe roughness	0.0025
Pipe environment temperature	45 °F
Load condensate temperature	150 °F
Steam trap leakage rate	15%

Table 10. Distribution heat loss estimates for baseline period, CHP systems E5126 and E3312.

Month	E5126 Losses (MBtu/hr)	E3312 Losses (MBtu/hr)
October 1990	2.1	14.5
November	32.4	14.6
December	32.8	14.7
January 1991	33.2	14.8
February	32.9	14.8
March	32.6	14.7
April	32.2	14.6
May	2.1	14.4
June	2.1	14.4
July	2.1	14.4
August	2.1	14.4
September	2.1	14.4

Table 11. Distribution loss estimates for baseline period CHP systems E4160 and E4225.

Month	E4160 Losses (MBtu/hr)	E4225 Losses (MBtu/hr)
Oct '89	1.8	0.5
Nov	1.9	0.5
Dec	2.0	0.5
Jan '90	1.9	0.5
Feb	1.9	0.5
Mar	1.9	0.5
Apr	1.9	0.5
May	1.8	0.5
Jun	1.8	0.5
Jul	1.8	0.5
Aug	1.8	0.5
Oct '91	1.8	0.5
Nov	1.9	0.5
Dec	1.9	0.5

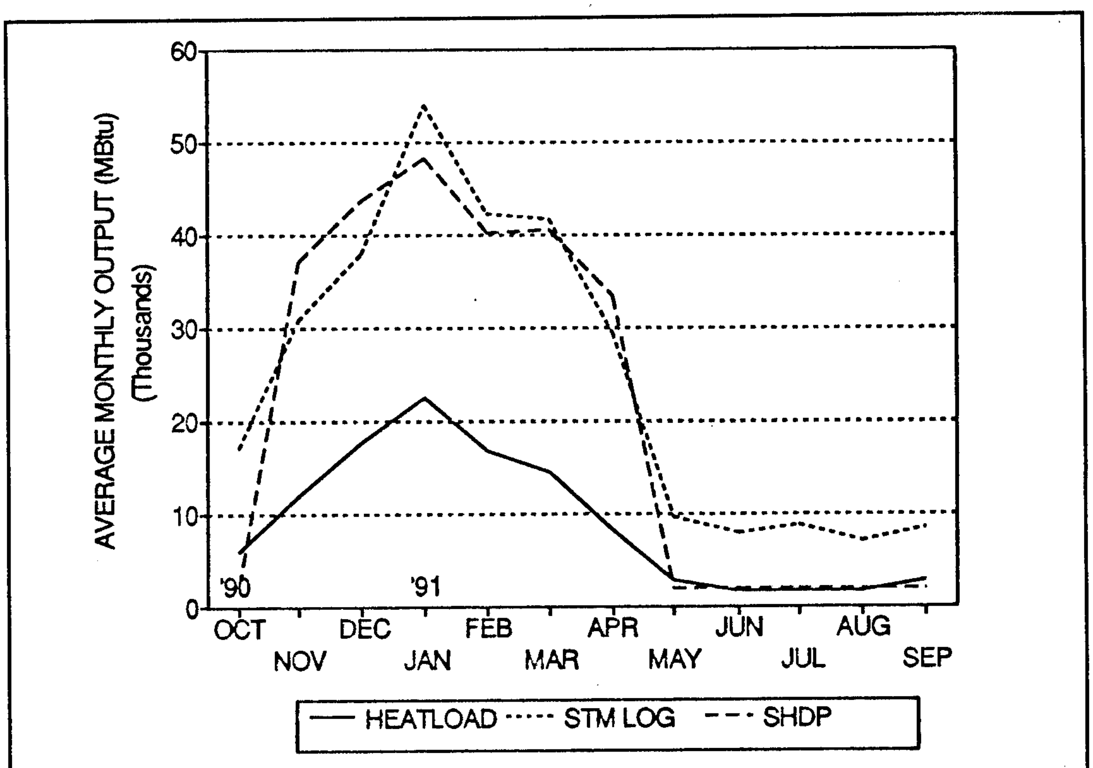

Figure 13. E5126 HEATLOAD with losses included.

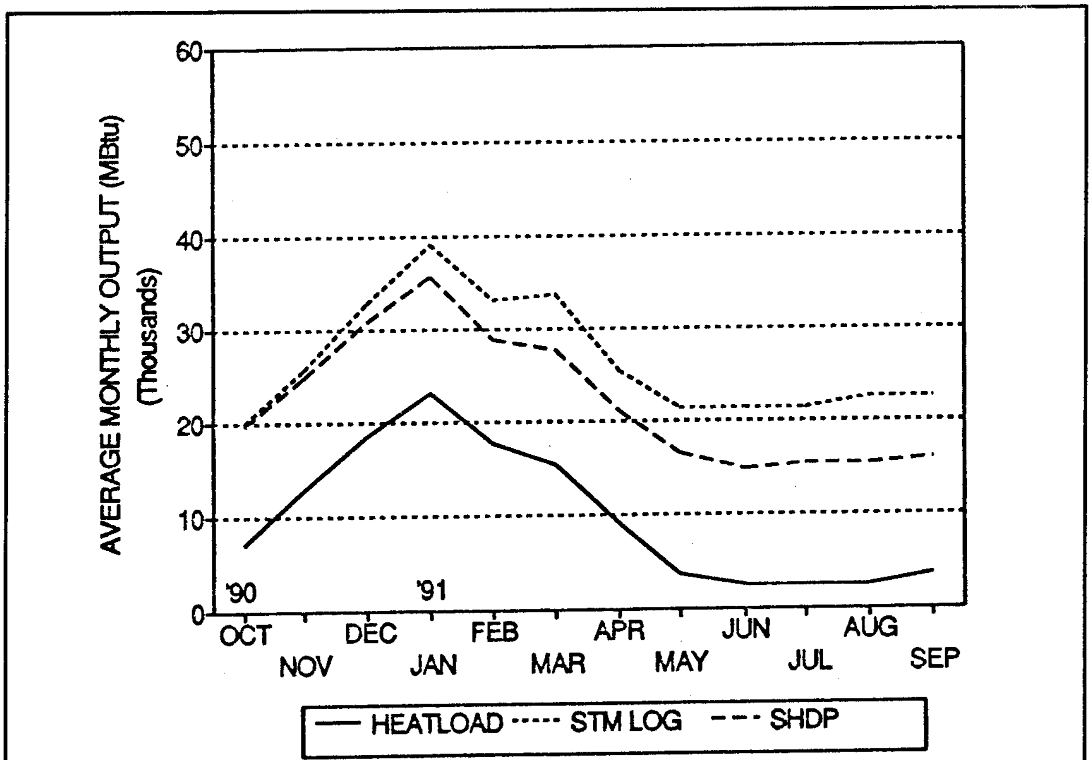

Figure 14. E3312 HEATLOAD with losses included.

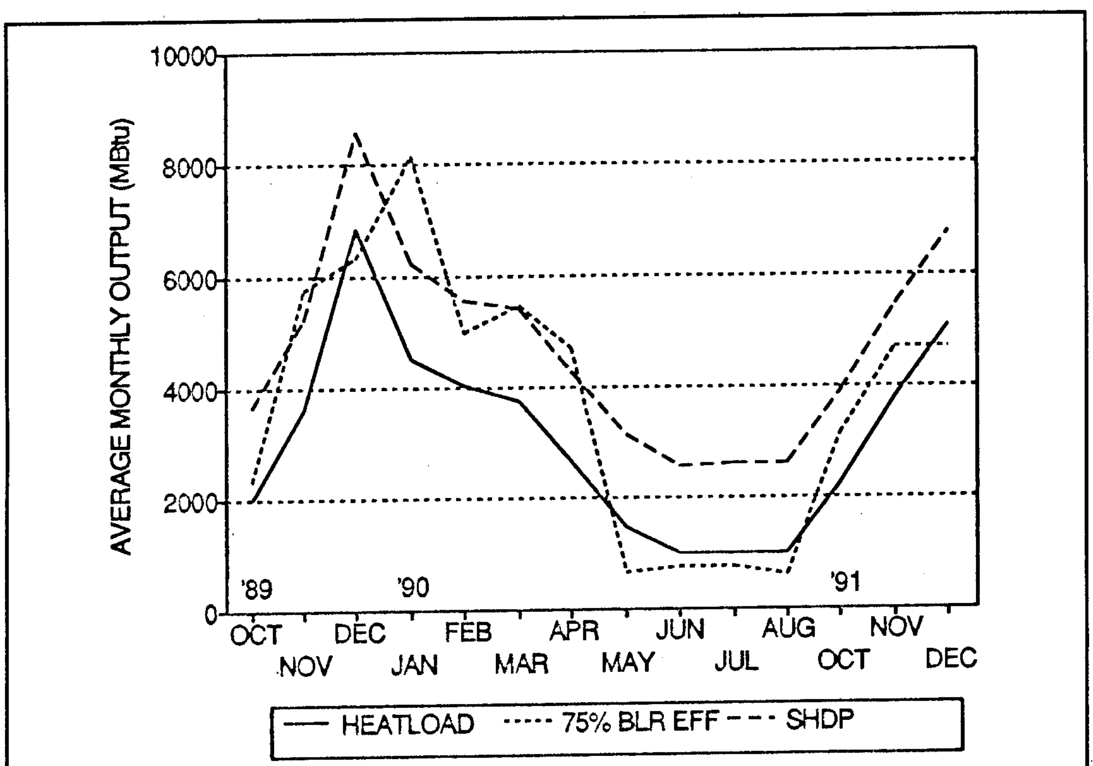

Figure 15. E4160 HEATLOAD with losses included.

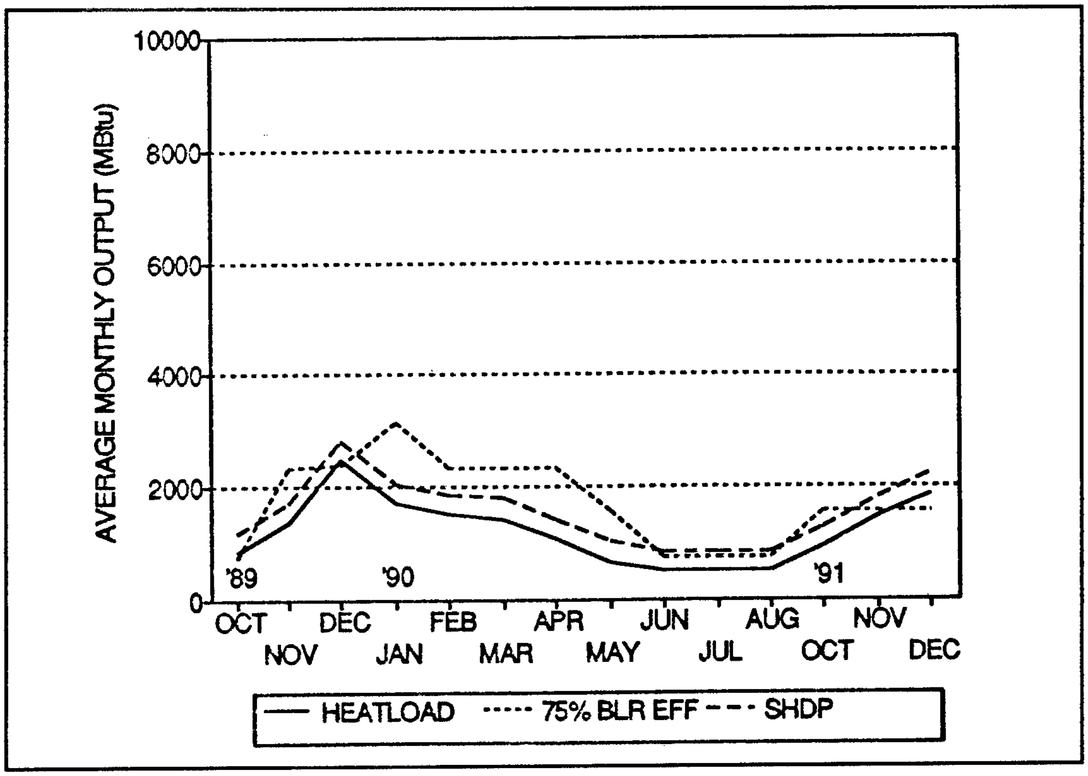

Figure 16. E4225 HEATLOAD with losses included.

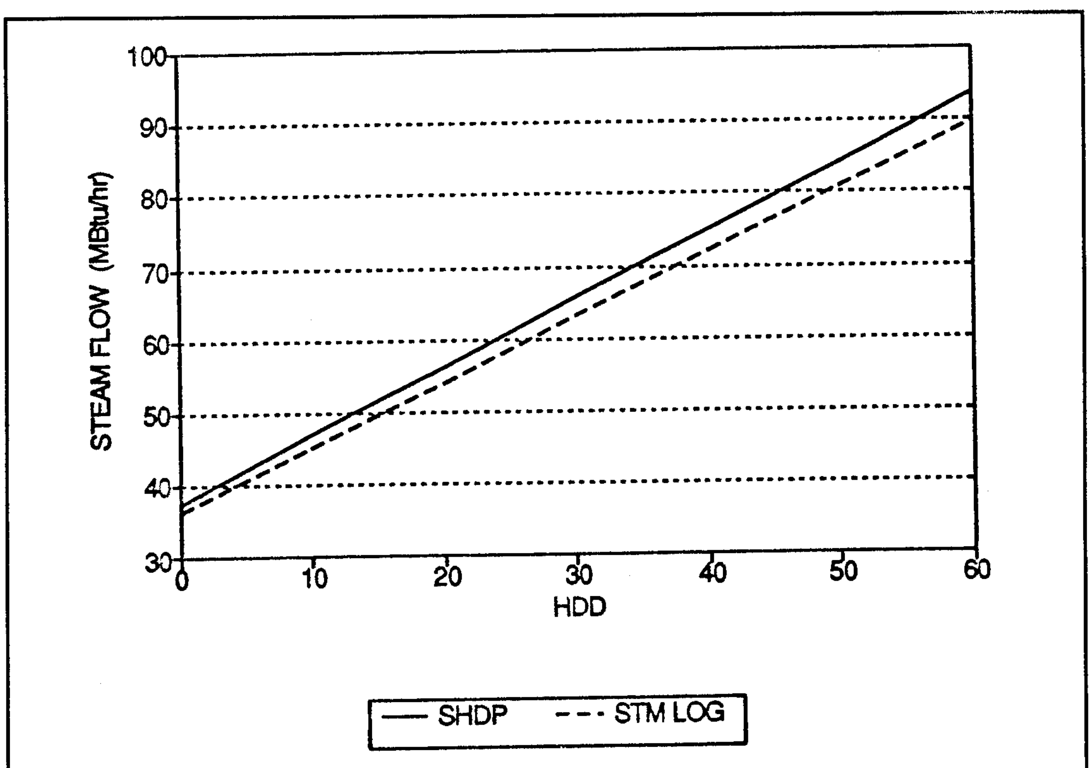

Figure 17. E5126 HDD regressions.

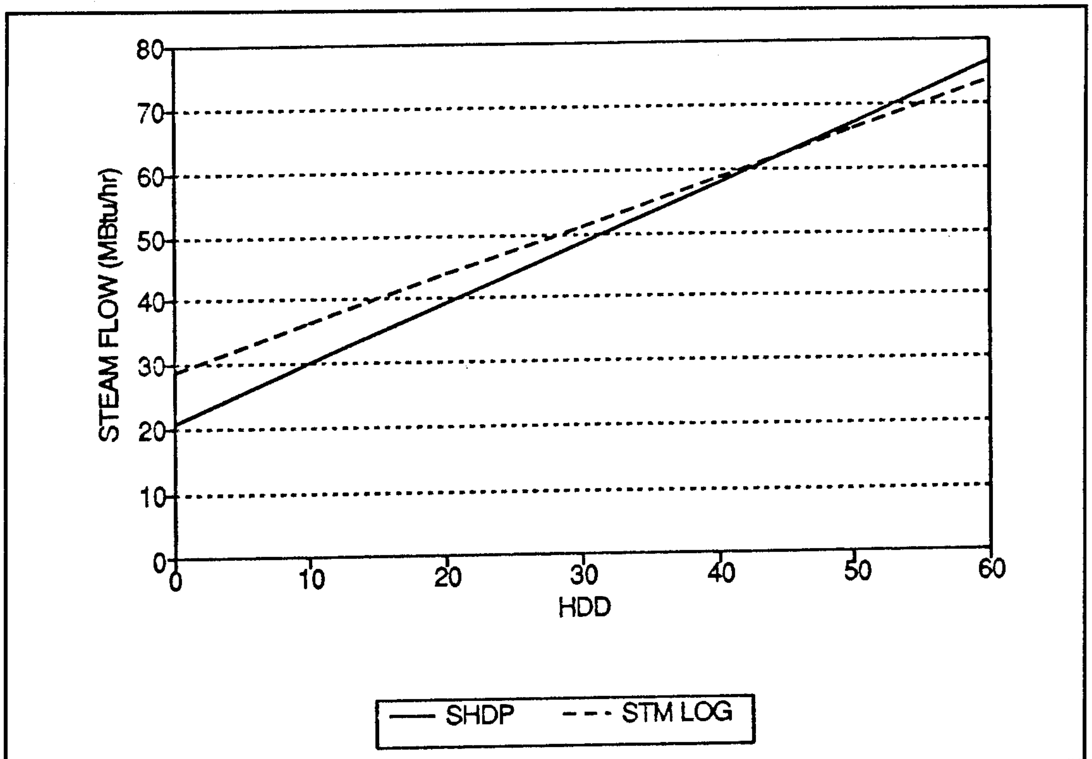

Figure 18. E3312 HDD regressions.

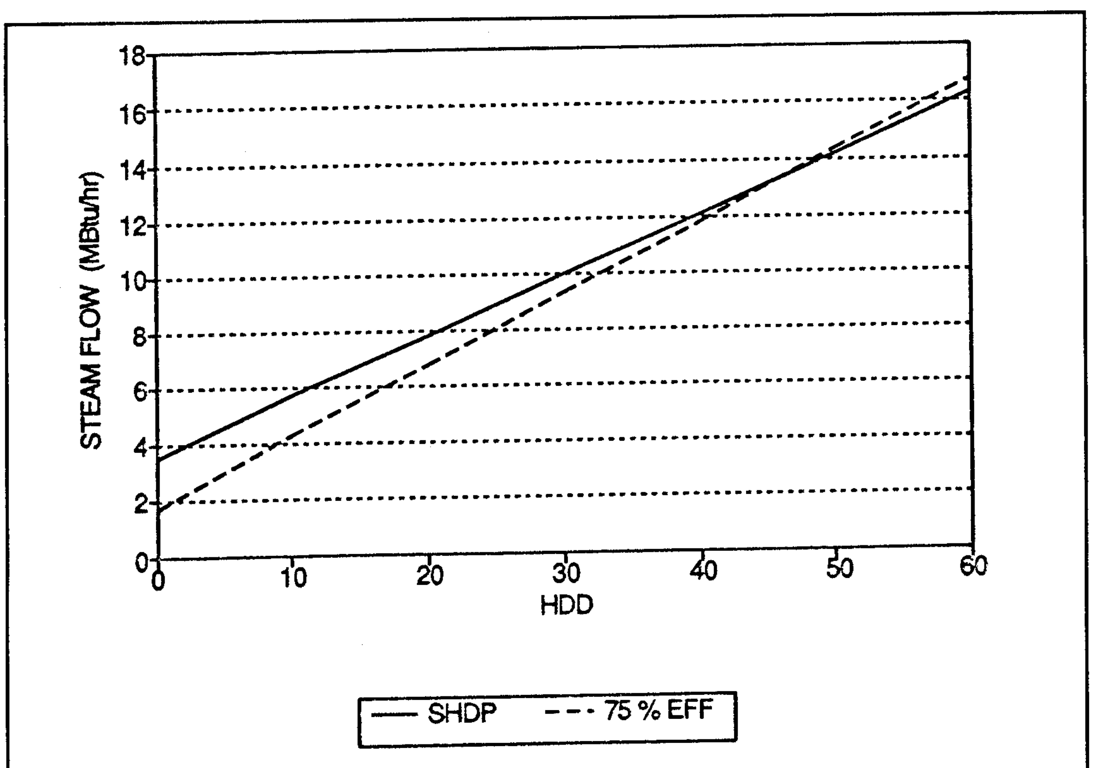

Figure 19. E4160 HDD regressions.

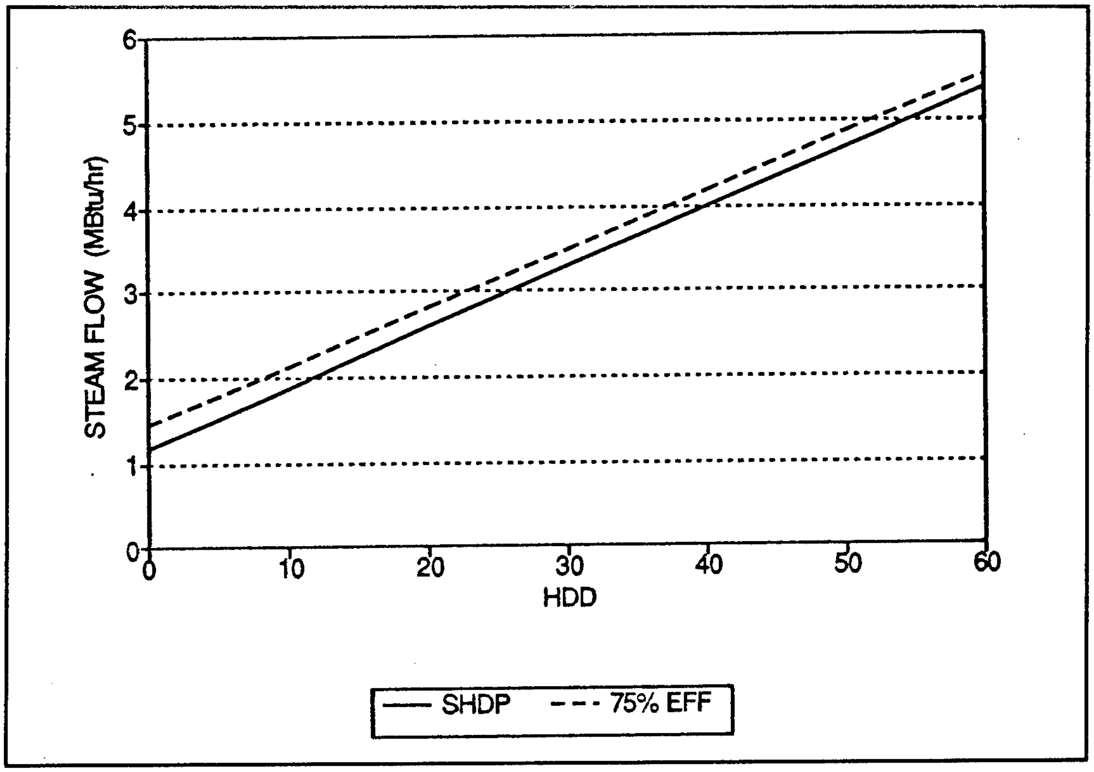

Figure 20. E4225 HDD regressions.

4 Electrical Power Consumption

This chapter describes current electrical energy supply and use. Electrical utility bills were analyzed to develop electrical use trends.

Electrical Costs

APG's electrical power is supplied by the Baltimore Gas and Electric Company (BG&E). The electricity costs are based on the Time-of-Day (TOD) rates Schedule P service. The electric bill consists of a three-tier energy usage charge, demand charge, customer charge, distribution charge, fuel rate charge, and various tax charges. However, APG owns its own distribution system so they receive a credit of $731.00 per month. The basic rate schedule is shown in Table 12.

The billed demand consists of both the production and transmission charge and the distribution charge. The production and transmission charge is for each kW of billing demand occurring during the on-peak rating period. The distribution charge is for each kW of billing demand recorded during any rating period. The billing demand is the maximum 30-minute measured demand, computed to the nearest kW, in each applicable rating period for the month. The measured demand is the customers rate of use of electric energy, but not less than 1500 kW.

APG 1991 electric bills were analyzed to determine the baseline consumption of electricity. Figure 21 shows the relative cost of demand, consumption, and fuel rate. This graph shows that during the winter, the fuel rate charge is the dominating cost and during the summer all three costs are fairly close to one another. The average summer monthly demand charge is $204,923 and the average summer monthly fuel rate charge is $179,657. The average summer monthly consumption charge is $204,487. The monthly average winter demand charge is $52,195, the monthly average winter fuel rate cost is $128,200, and the average winter monthly consumption cost is $92,794, which together provide an average electrical cost of $0.0425/kWh in the winter and $0.064/kWh in the summer.

Development of a Cooling Degree Day Model

One method of projecting loads is to develop a linear model based on a previous year. For APG, models of both peak demands (kW) and consumption (kWh) were required because electric bills are based on peak kW and monthly kWh. Although peak demands and consumption are affected by many factors, they are highly dependent on cooling degree days (CDD). Regression analyses were made between 1991 CDD data and the peak KW and monthly kWh. The demand regression is shown graphically in Figure 22. The regression has a correlation coefficient of 0.87, indicating a strong correlation between CDD and peak demand.

Figures 23 through 25 show the regression between monthly consumption and monthly CDD data. The regression correlation coefficient is 0.73 for the on-peak consumption, 0.59 for the intermediate-peak consumption, and 0.62 for the off-peak consumption. The correlation between CDD and monthly consumption is not quite as strong as that of demand but there is still a strong relationship. The points grouped near the origin (zero CDD) are those months that have no cooling load. The total monthly noncooling electric load is approximately 5,778,000 kWh.

These regressions or models were then used to project long-term (Normal) energy use patterns. (Appendix C describes the cooling equipment at APG.)

Projected Energy Consumption

In the previous chapter, energy data from 1-year time frames were analyzed through mathematical regression analysis to determine energy consumption as a function of HDD and CDD. However, the analyzed time frame may not be typical of the long-term weather conditions. To better predict the energy consumption over a 25-year life cycle, these regressions were applied to the long-term or Normal HDD and CDD.

To predict the Normal weather conditions of APG, weather data from 1950 to 1985 were analyzed to determine the HDD and CDD of a normal year. Table 13 presents the Normal monthly HDD and CDD.

The regression models were then applied to these HDD and CDD to predict the normal monthly steam consumption for each boiler plant and the normal monthly electricity demand and consumption. The normal monthly steam and electricity requirements are presented in Tables 14 and 15.

These projections do not include the steam use of the proposed toxicology laboratory. The steam use of this building is not known as a function of HDD; however the peak use is projected to be about 26 klbs/hr at 125 psig or 31 MBtu/hr. This steam consumption was considered when boiler and piping system sizes were calculated.

These projected normal monthly energy consumption values were used as the baseline energy consumption values for all of the investigated design alternatives.

Table 12. Electric rate schedule.

Customer Charge:	$750.00	Per Month
	(JUN-SEP)	(OCT-MAY)
Demand Charges:		
Prod. & Trnas.	$12.09 per kW	$5.99 per kW
Distribution:	$ 2.33 per kWh	$2.33 per kWh
Energy Charge:		
On-Peak	$0.03790 per kWh	$0.02257 per kWh
Intermediate	$0.02742 per kWh	$0.02037 per kWh
Off-Peak	$0.01468 per kWh	$0.01174 per kWh
Fuel Rate Charge:	$0.01375 per kWh	$0.01375 per kWh

Rating Periods:

Summer
- On-Peak - Between the hours of 10 am and 8 pm on weekdays.
- Intermediate-Peak - Between the hours of 7 am and 10 am, and the hours of 8 pm and 11 pm.
- Off-Peak - All other times.

Non-Summer
- On-Peak - Between the hours of 7 am and 11 am, and the hours of 5 pm and 9pm on weekdays.
- Intermediate-Peak - Between the hours of 11 am and 5 pm on weekdays.
- Off-Peak - All other times.

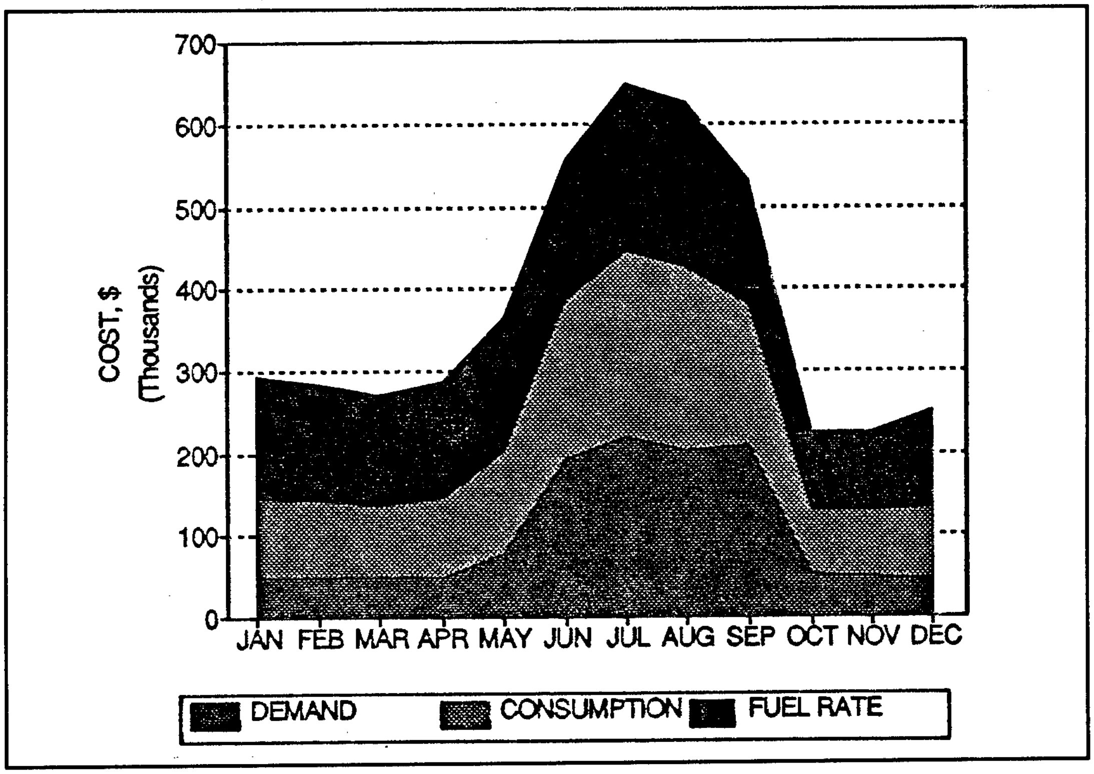

Figure 21. APG monthly electrical costs.

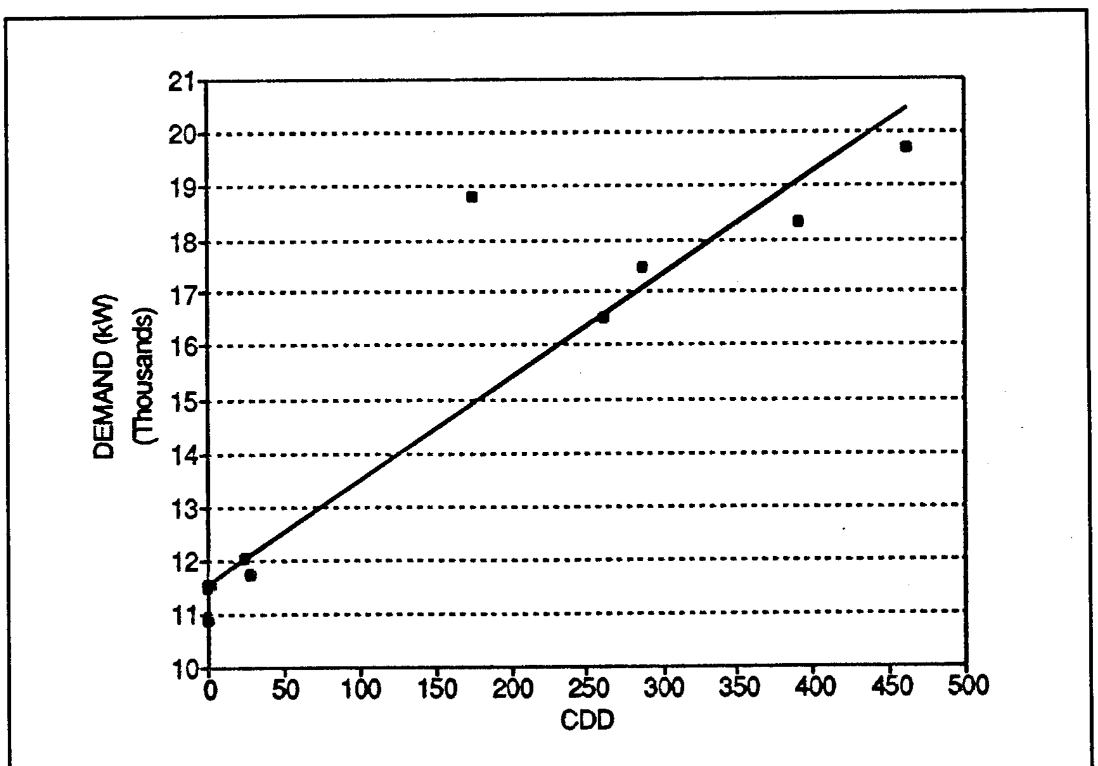

Figure 22. On-peak consumption vs CDD.

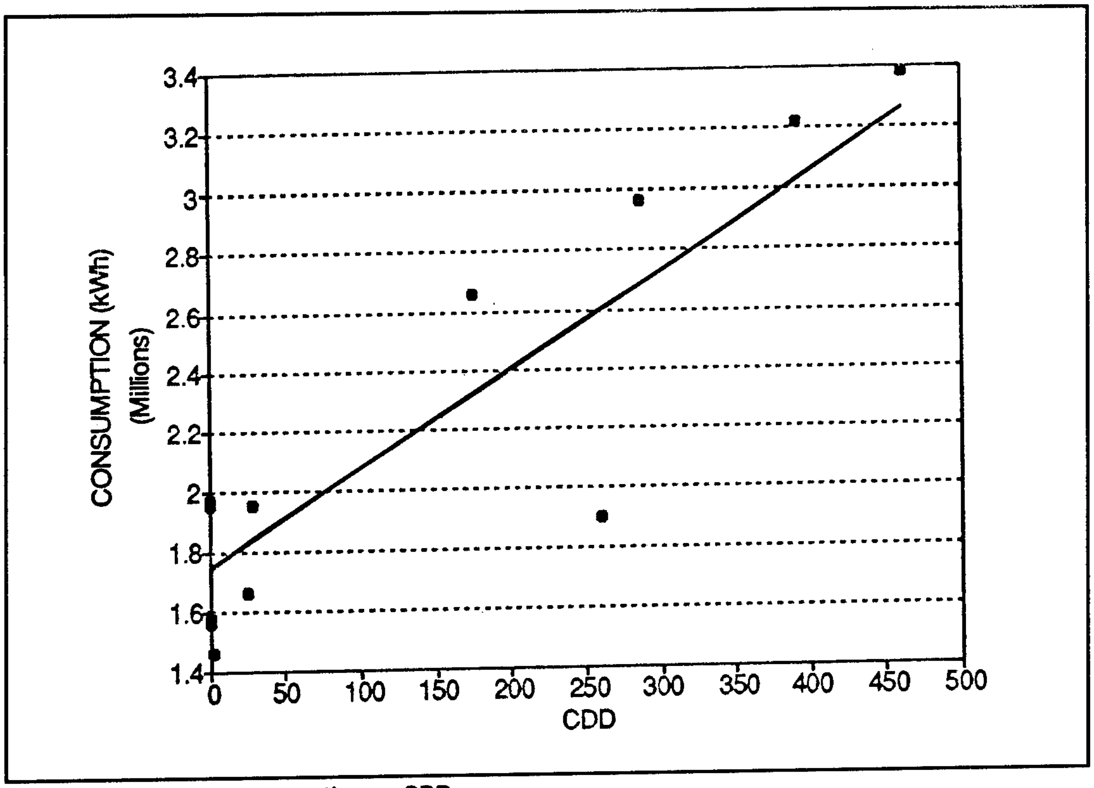

Figure 23. On-peak consumption vs CDD.

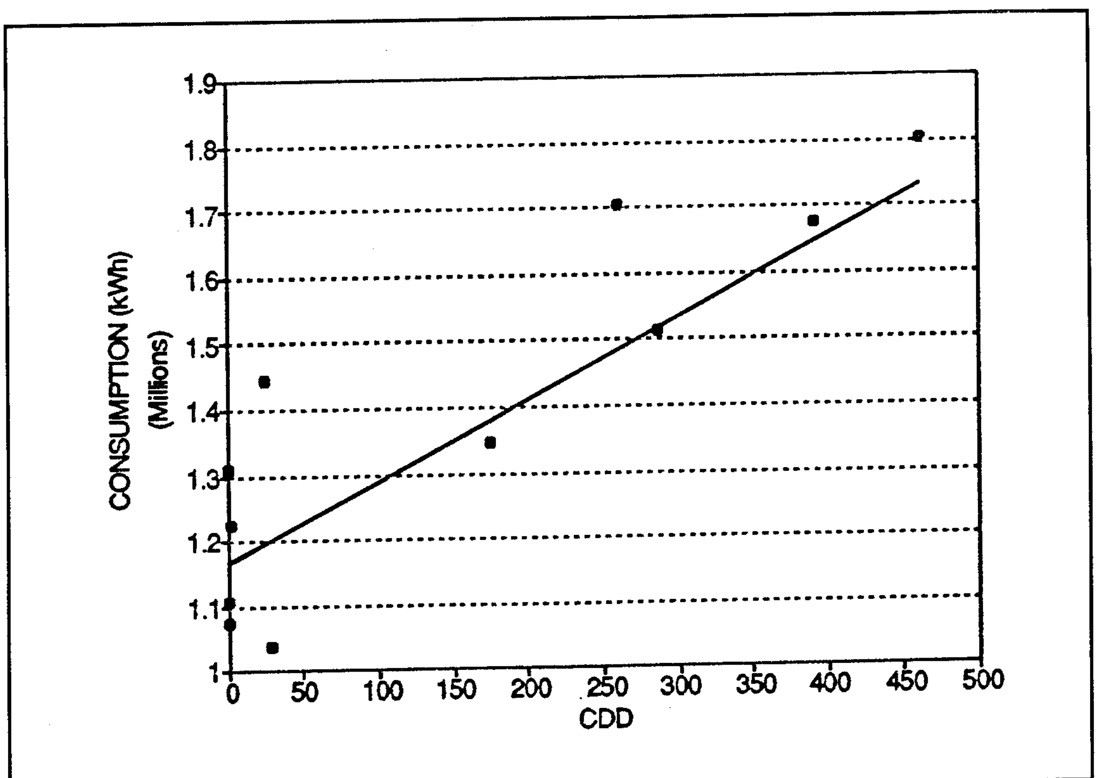

Figure 24. Intermediate-peak consumption vs CDD.

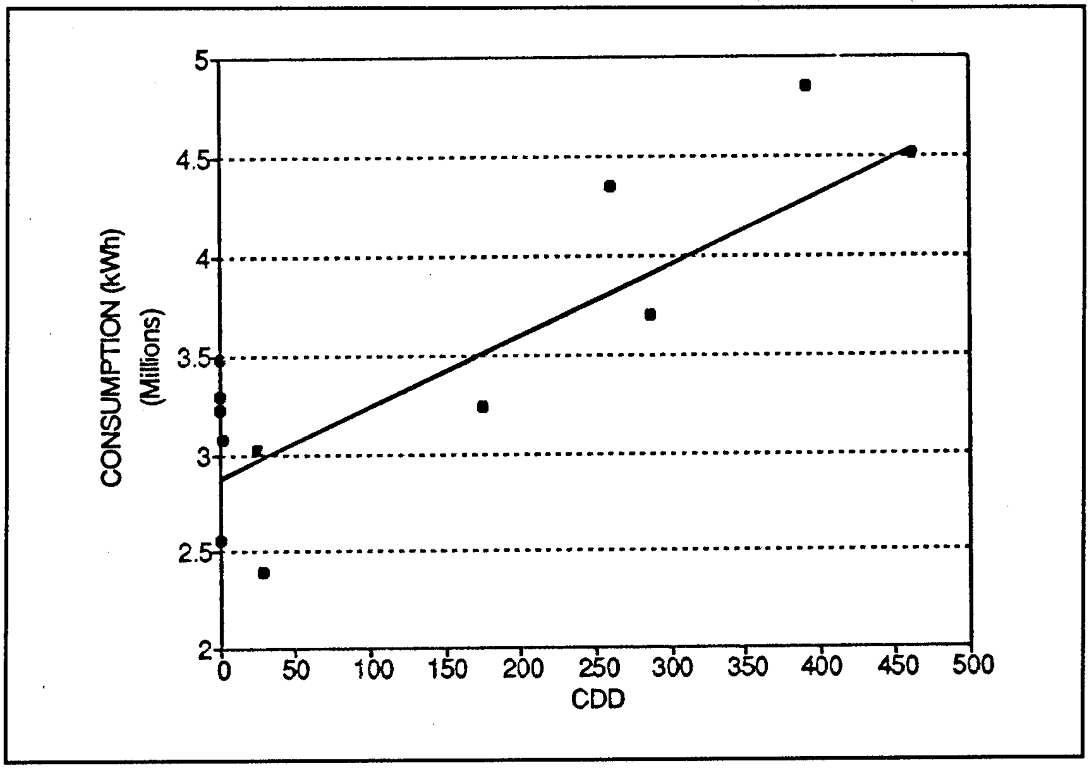

Figure 25. Off-peak consumption vs CDD.

Table 13. Normal monthly HDD and CDD.

Month	HDD	CDD
JAN	924	0
FEB	761	0
MAR	592	3
APR	290	26
MAY	89	97
JUN	8	256
JUL	0	390
AUG	1	356
SEP	36	184
OCT	225	31
NOV	488	4
DEC	837	0

Table 14. Normal projected steam requirements.

Month	E5126 (MBtu)	E3312 (MBtu)	E4160 (MBtu)	E4225 (MBtu)
Jan	46,784	37,983	6,877	2,581
Feb	40,693	32,990	5,770	2,213
Mar	39,702	32,017	4,877	2,042
Apr	32,403	25,914	3,021	1,519
May	9.110	22,986	1,850	1,227
Jun	8,105	20,837	1,319	1,060
Jul	8,304	21,390	1,315	1,082
Aug	8,310	21,403	1,320	1,084
Sep	8,363	21,349	1,490	1,106
Oct	31,876	25,423	2,667	1,447
Nov	36,619	29,466	4,211	1,839
Dec	44,939	36,429	6,356	2,441

Table 15. Normal projected electricity requirements.

	Demand	----------Consumption----------		
Month	(kW)	On-Peak (kWh)	Int-Peak (kWh)	Off-Peak (kWh)
Jan	11,534	1,742,037	1,164,974	2,870,985
Feb	11,536	1,742,367	1,165,097	2,871,345
Mar	11,591	1,751,597	1,168,537	2,881,438
Apr	12,031	1,826,757	1,196,552	2,963,623
May	13,416	2,062,788	1,284,529	3,221,714
Jun	16,486	2,586,273	1,479,650	3,794,126
Jul	19,075	3,027,676	1,644,177	4,276,783
Aug	18,408	2,913,947	1,601,786	4,152,424
Sep	15,084	2,347,276	1,390,568	3,532,791
Oct	12,138	1,844,888	1,203,310	2,983,449
Nov	11,610	1,754,893	1,169,766	2,885,043
Dec	11,540	1,743,026	1,165,342	2,872,066

5 Air Quality Regulations

Air quality regulations are the most significant environmental regulations that will affect the analysis of alternatives for this study. The Clean Air Act Amendments (CAAA) of 1990 are putting tighter constraints on emissions from most industrial sources, particularly combustion sources.

Federal Regulatory Requirements

The state of Maryland is divided into six control districts and is classified as part of the Northeast Transport Region. Harford county is located in control district number 3, which includes Anne Arundel, Baltimore, Carroll, Harford, and Howard counties. The entire state of Maryland is in attainment for SO_2, PM_{10}, and NO_2. Baltimore is classified as a moderate nonattainment area for CO (< 12ppm). Also, Harford county has been designated as a severe nonattainment area for O_3.

The Clean Air Act Amendments of 1990 establish emission limits for O_3 precursors in areas designated as severe O_3 nonattainment. The emission limits for O_3 precursors (volatile organic compounds [VOC] and nitrogen oxides [NOx]) are set at 25 ton per year (TPY). These rules became effective on 15 November 1992. The emission thresholds defining a major modification to an existing major source in a non-attainment area under the previous rules have not been modified by the 1990 CAAA. However, the 25 TPY major source definition is less than the old major modification definition. A major source is also defined as "any physical change or change in method of operation at an existing nonmajor source that constitutes a major stationary source by itself." Therefore, any existing source that increases emissions of VOC or NO_x by 25 TPY is subject to nonattainment NSR.

A source that is subject to nonattainment NSR in a severe O_3 area must install emission control equipment that meets Lowest Achievable Emission Rate (LAER) requirements and obtain offsetting emissions decreases from existing sources at a ratio of 1.3:1. However, if best available control technology on VOC emissions is in place on existing equipment, then a 1.2:1 reduction is sufficient. Emissions offsets could also be obtained from reduced operation of the Owner's existing boilers at a ratio of 1:1.

The 1990 CAAA requires Reasonably Available Control Technology (RACT) on all existing fuel burning equipment built before 12 May 1972.

State and Local Regulatory Requirements

A permit to construct must be obtained for construction of new sources in Maryland. Information on permit procedures and costs can be obtained from the Maryland Air Management Administration. The Maryland state air quality agency, located in the Department of the Environment in Baltimore, enforces federal, state, and local air quality regulations. Maryland state regulations limit SO_2 emissions from new source to 500 ppm and 2,000 ppm for existing sources. Sulfur content in region 3 is limited to 0.3 percent for distillate fuel. Nitrogen dioxide standards for new facilities burning liquid fuel is limited to 0.3 lb/MBtu. For existing sources, reasonably available control technology must be used to reduce NO_x emissions.

Effect on Alternatives

The installation of absorption chillers effects APG's energy requirements in two ways. It increases the steam consumption and it decreases the electrical consumption. In alternative 4 option 2, the absorption chiller increases APG's steam consumption by 7,953 MBtu/yr. However, this chiller operates mostly during months in which APG does not meet its minimum monthly required steam demand, when the WEP is still required to produce this minimum amount and blow-off the unused steam. As a result, the absorption chiller will actually only increase steam production by 1,876 MBtu/yr, which translates into an increase in NO_x emissions of 987 lbs/yr, or close to 0.5 tons per year (TPY).

Alternatives 2 and 6 will not increase energy consumption at APG. They only shift the energy production from one source to another. Therefore, they should not cause any problems with air quality regulations.

6 Study Alternatives

Seven alternatives were evaluated with various options. Life cycle cost (LCC) analyses were performed on each alternative using the Life Cycle Cost in Design (LCCID) program.

The implementation of one alternative will influence the result of another alternative. For example, connecting the E4000 area to the WEP system (Alternative 2) will increase the boiler sizes required in the consolidation of the CHPs and will affect the Status Quo alternatives by eliminating CHP E4225. Also, the installation of absorption chillers (Alternatives 4 and 5) will influence the boiler sizes needed in CHP consolidation (Alternative 6).

To address this problem, each alternative was first evaluated alone. If an alternative was then recommended for implementation, its effects were then considered on the sizing of equipment for other recommended alternatives (Chapter 7).

Alternative 1 - Status Quo

The status quo alternative was developed using the STATUS QUO model developed by USACERL to provide a microcomputer-based technique to establish the LCC of an existing CHP. The model development was funded by the DOD Coal Use Program. The "status quo" situation implies the continued operation of the CHP by performing routine maintenance, repair, and replacement of major equipment based on expected life. The STATUS QUO model provides a baseline alternative with which to compare CHP plant alternatives. This alternative will serve as a baseline for comparison between alternatives 1 and 6.

The evaluation of the CHP's status quo is determined through field survey and the completion of an evaluation form for major plant components. The model is capable of estimating the life expectancy and cost of oil, natural gas, and coal-fired equipment for boilers in the 20 to 200 MBtu/hr range and a maximum plant capacity of 600 MBtu/hr. The model data input is simple, consisting of equipment size (dimensions, capacity, power requirements, etc.) and year of installation. The STATUS QUO program will display (for each component) equipment cost in 1991 dollars and the year the equipment should be replaced. Costs are based on average industry prices and the replacement year is based on industry experience.

The program also allows the default values to be changed if better information is available. For instance, a good method of establishing watertube boiler life is by measuring the steam drum thickness and comparing it to the original thickness and pressure rating. Boiler codes limit allowable pressures that are based on drum thickness. Available methods can help determine the condition and life expectancy of many other components. Some of these condition indication methods include: vibration analysis, motor testing, ultrasonic listening, thickness testing, oil analysis or ferrography, infrared thermal surveys, eddy current testing, equipment performance tracking, and equipment run time.

The program also contains defaults for labor, maintenance, spare parts, and utility costs. Actual costs should be used to obtain an accurate economic analysis. The STATUS QUO model uses the LCCID program to perform the life cycle cost analysis. The STATUS QUO program produces an LCCID input file containing all the plant components with their replacement year, replacement cost, plant labor, maintenance, spare parts, and utility costs.

Table 16 shows the LCC summary for maintaining the Status Quo of all CHPs. Costs are Net Present Worth (October 1993 basis).

A complete list of improvements required at each central heating plant is included in Appendix D as part of the LCCID Status Quo analysis performed on each CHP.

Alternative 2 - Connect E4000 Area to WEP

The E4000 area is currently serviced by two small distribution systems and two small CHPs. This alternative involves connecting both CHPs E4160 and E4225 to the WEP line.

Personnel at APG decided to reroute the entire distribution system in the E4000 area for this alternative. Figure 20 shows the new distribution system. CHP E4225 is connected to E4160 with a 4-in. steam line. The use of the boilers in E4225 will be discontinued.

CHP E4160 is connected to the WEP line with an 8-in. steam line that will carry steam at the WEP steam pressure. This pressure will then be reduced from 350 psig to 100 psi at E4160. Steam will be supplied to E4225 at 100 psig and distributed through its local network. A pressure-reducing valve will be located on the main 8-in. branch that services the E4400 area. This valve will reduce the upstream pressure from 100 psig to a downstream pressure of 25 psig.

After implementing these changes, the WEP would supply steam to all of the E4000 area until the WEP output capacity was met. At this time, boilers in E4160 would be brought on-line to carry the rest of the load.

If the WEP shuts down, E4160 will be required to carry the full steam load for the E4000 area. E4160 currently has a steam capacity of 18.5 MBtu/hr. The steam demand in the E4000 area for the design day of 54 HDD is 20.4 MBtu/hr. Therefore, if CHP E4225 is to be shut down, another boiler must be installed in E4160. It is recommended that a 16.8 MBtu/hr (500 HP) firetube boiler be installed in E4160 to meet the steam demand. This size of boiler would also allow for some expansion in this area. Boiler No. 2 at E-4160 is 350 HP (the maximum possible size due to space limitations).

The new distribution system was modeled using SHDP to determine if line sizes were adequate to meet the steam demands. It was determined that the proposed system would be sufficient. In extreme conditions of 65 HDD, steam pressure at E4225 would be 77 psig. The lowest pressure experienced for these conditions would be 20.2 psig at building E4460. Therefore, the proposed line sizes are adequate and do allow for future expansion in this area.

Alternative 3 - Closing the Steam Loop

Alternative 3 involves closing the steam loop from the E5000 area to the E3000 area. This will be done by installing an underground steam line from E5126 to E3148 and a line from E-3148 to E-3312.

Steam loop completion is required to gain better and more reliable use of WEP steam and to save infrastructure, energy, and O&M dollars. New E-5126 boilers are rated at the same pressure as WEP steam. Part of the loop can use steam from E-5126. (The losses are greater if the loop is not closed.)

The toxicology laboratory (in the Life Sciences Building) has a great summer and winter demand. The 8-in. diameter WEP steam line currently in use from Building E-5126, via E-4160, E-3312 and the new pressure reducing building near building E-3148 may not have adequate pressure or flow of steam due to size restriction, etc.

A feasibility study is currently being done of a large MCA project (a consolidation of 9 AEHA facilities). It is highly possible that the project will be located in the location north of Chevron Drive and east of Family Housing. Most of the heavy steam requirements are near E-3148; the largest loads in the area are in the toxicology laboratory, E-3081, E-3100, E-3160, and the new AEHA complex.

Manpower is short at APG. If the steam loop is closed, one EMCS system operator can manage the dispatching of steam, monitor major central heating plants, and monitor WEP steam parameters and load requirements in various areas. If the loop is not completed, replacement cost for the piping system serving the E-3300 and E-3200 blocks will be much higher. If the loop is completed and the new building near E-3148 and the toxicology laboratory (the PRV Building) could be used as a hub and distribution center for 125 psig steam in the vicinity. The 6-in. diameter steam line from E-3312 to E-3081 can be retrofitted and used as a main with all the branches from the old line connected to this line. A new 8-in. diameter 350 psig steam line was designed and a contract has been awarded for its construction.

APG received a contingent approval from the Power Procurement Office on contract for natural gas service from BGE in the Aberdeen Area of APG. BGE will own, operate, and maintain the gas line at a cost to APG of less than $300K. The next logical step is to install gas service at the Edgewood area within the next 5 years since the natural gas requirement at the Edgewood area APG in one location (E-5126) is more than half the load at the Aberdeen Area at 17 different locations.

This alternative was modeled on SHDP to determine the proper line size and pressure. It was determined that this line would have to be supplied at the pressure of the WEP steam. A pressure of 125 psig was inadequate to supply steam around the loop. The WEP steam pressure was set at 350 psig and the system was executed with unconstrained pressure to determine the available pressure at each CHP.

Since the purpose of this line is to add better reliability to the steam system, the model was run with the WEP line from E5126 to E4160 disconnected to assure that the new line would be adequate to supply the full load. Table 17 shows the available CHP steam pressures and the available pressure at E3148 under these conditions for both a 10-in. and 12-in. pipe used as connections for closing the steam loop. Also considered in this model were the effects of the proposed toxicology laboratory. It was estimated that this lab will consume a maximum of 26,000 lb/hr of steam at 125 psig. To account for this consumption, this steam load was modeled as part of building E3148 to ensure the steam line would be adequately sized.

It was found that a 10-in. line would not be adequate to supply the needed pressure to all CHPs. Therefore, the 12-in. line must be used to connect E5126 to E3148, and E3148 to E3312. This alternative consolidates CHPs E5126, E4160, and E4225. Boilers 1, 2, 3, 4, and 5 will be demolished and two new package boilers rated at 70 MBtu/hr will be installed in CHP E5126. Table 18 presents the LCC for this option. For this option, plant E3312 is still utilized. Therefore, the LCC of maintaining E3312 is added into this option.

Alternative 4 - Absorption Chiller Plant 1

Alternative 4 involves air-conditioning buildings E3510 and E3516. Option 1 involves keeping the current air-conditioning system and replacing old equipment when needed with the same type of equipment. This option forms a baseline for comparison with the installation of a chilled water system. Table 19 presents the life cycle cost for this option. To more accurately predict the energy requirements for both options 1 and 2, energy costs are the cost for the entire base and not just the energy costs required for cooling the two buildings. Therefore, the life cycle costs presented can only be used to compare the two options. They should not be used to predict the actual cost of the project.

Option 2 investigates the use of chilled water, supplied by a steam absorption chiller, to air-condition buildings E3510 and E3516. The absorption chiller will be housed in a pre-engineered building and will supply chilled water via an underground chilled water distribution system to the two buildings. Table 20 presents the life cycle cost for this alternative.

The LCC of these two alternatives are close enough together so that either alternative is reasonable. (Note that a contract has been awarded for absorption chillers for Building E-3510 with provisions for space in another pre-engineered building for another absorption chiller for E-3516.)

Alternative 5 - Absorption Chiller Plant 2

Alternative 5 involves air-conditioning buildings E3081, E3100, and the proposed toxicology laboratory. Option 1 looks at keeping the current air-conditioning system at buildings E3081 and E3100 and replacing old equipment when needed with the same type of equipment. This option forms a baseline for comparison with the installation of a chilled water system (Option 2). Table 21 gives the life cycle cost for this option. To more accurately predict the energy requirements for Options 1, 2, 3, and 4 energy costs are assumed to be the cost for the entire base and not just the energy costs required for cooling the designated buildings. Therefore, the life cycle costs presented can only be used to compare the two options. They should not be used to predict the actual cost of the project.

Option 2 investigates the use of chilled water, supplied by a steam absorption chiller, to air-condition buildings E3081 and E3100. The absorption chiller will be housed in building E3148 and will supply chilled water via an underground chilled water distribution system to the two buildings. Table 22 gives the life cycle cost for this alternative. A comparison of these two options shows that the current cooling method is much more LCC effective.

Option 3 uses centrifugal chillers for cooling the toxicology laboratory. This assumes the centrifugal chillers will be located at the toxicology laboratory so no lengthy distribution system is needed. Table 23 presents the LCC for this option.

Option 4 involves absorption chilling of the toxicology laboratory. Current plans are for the toxicology laboratory to have its own absorption chiller in the laboratory's mechanical room. Table 24 gives the LCC for this option. A comparison of options 3 and 4 shows that the toxicology laboratory should be air-conditioned with centrifugal chillers.

Alternative 6 - Consolidate Central Heating Plants

This alternative involves combining all the CHPs into one CHP. Alternative 1 serves as the baseline for the options presented in this alternative. Each option includes costs for dry layaway of the current boilers in the unused CHPs.

The Central Heating Plant Economics (CHPECON) evaluation program was used to determine new equipment sizes and costs for both options 1, 2, and 3. CHPECON, which was developed by the Institute of Gas Technology for USACERL and was funded by the DOD Coal Use Program, is a computer program used for evaluating new and retrofit central heating plant opportunities. This program can be used to evaluate CHPs in the range of 60 to 500 klbs/hr steam with boiler sizes in the range of 20 to 200 klb/hr. CHPECON also includes a detailed cost evaluation model for predicting LCC of new and retrofit projects.

In this study, CHPECON was used to help predict equipment sizes along with equipment costs, energy consumption costs, and annual operation and maintenance costs for each option. CHPECON uses the monthly heating demand profiles for the study year to calculate a plant maximum continuous rating and determine the proper size of the boilers to meet the load.

Option 1 looks at constructing a new building for the CHP located next to E5126. This new plant will house three new package boilers each rated at 90 MBtu/hr. Table 25 presents the LCC for this option.

Option 2 involves making E5126 the main CHP. For this option, Boilers 1, 2, 3, 4, and 5 will be demolished and three new package boilers rated at 70 MBtu/hr will be installed. Table 26 presents the LCC for this option.

A comparison of Alternatives 1, 3, 6 (Option 1), and 6 (Option 2) shows that Alternative 6 Option 2 is the most LCC effective of the alternatives. However, Alternative 3 would provide more reliable steam distribution to all areas at a slightly higher cost (cf. Tables 18 and 26). Also, Alternative 3 would anticipate the eventual construction of the AEHA Area by allowing easy connection of the AEHA Area to the steam line that would run between E5126 and the Toxicology Laboratory.

Alternative 7 - Fix Steam and Condensate Leaks

This alternative investigates the benefits of replacing the condensate line that runs from E3312 to E3580, a 4-in. aboveground condensate return line; it cannot realistically be compared with the other alternatives. This alternative was studied to determine its cost-effectiveness, which is independent of the selection of any of the other alternatives (1-6).

Figure 27 shows the location of this line and the buildings it services. This figure actually shows the existing steam line. The corresponding condensate line would run alongside the steam line. This line is to be replaced with a 6-in. aboveground condensate line. For this analysis, it was assumed that the old line would be demolished and the new line would be installed on the existing stanchions of the old line.

The existing line consists of a 4-in. diameter steel pipe with 1-in. of asbestos insulation surrounded by metal jacketing. Since asbestos is considered a hazardous substance, special considerations were accounted for in the cost of demolition. This cost includes removal of the insulation, glove-bagging the elbows, bagging the removed insulation, and disposal of the insulation. For demolition of the steel pipe, it was assumed the pipe would be cut into sections with a torch and removed.

A series of LCC analyses were performed to determine if this line should be replaced. For these analyses, the energy considered was that in the condensate that could be returned if there were no leaks. Table 27 shows the amount of condensate that should be returned each month if there were leaks. Also considered were the cost of the water lost and the cost of chemicals for treating makeup water.

To determine when the pipe should be replaced, LCCs were performed over a range of percent condensate leakage. Figure 28 represents the results of this analysis. The line labeled "Replacement" represents the LCC of replacing the existing line and the benefits of energy saved by fixing the condensate line. The line labeled "Existing" represents the LCC of keeping the old condensate line. The intersection of these two lines represents the percentage of condensate loss required for the replacement of this line to be economical. It follows that this line should not be replaced until condensate losses of 15 percent or more are experienced. It is estimated that current condensate losses are approximately 15 percent. Also, this line may be contributing to water pollution in the area since chemicals used to treat this water are dissolved in the water, which is leaking out onto the ground; the line should be replaced.

Table 28 presents a breakdown of the LCC for replacement of the condensate return line for the condition of condensate losses equal to 15 percent. Energy, water, and chemical costs are negative for this case because these items are conserved by replacing the condensate pipe. The energy savings is based on the cost of No. 2 fuel oil and a boiler efficiency of 80 percent for the boilers in CHP E3312.

Table 16. Alternative 1 - status quo LCC summary.

Category	Costs	
Initial Investment		0
Energy costs:		
Electricity	657,836	
No. 2 oil	21,069,488	
Purchased steam	98,450,378	
Total energy		120,177,702
Recurring M&R/custodial		16,539,952
Major repair/replacement		4,509,184
LCC of all costs/benefits (net PW)		141,226,838

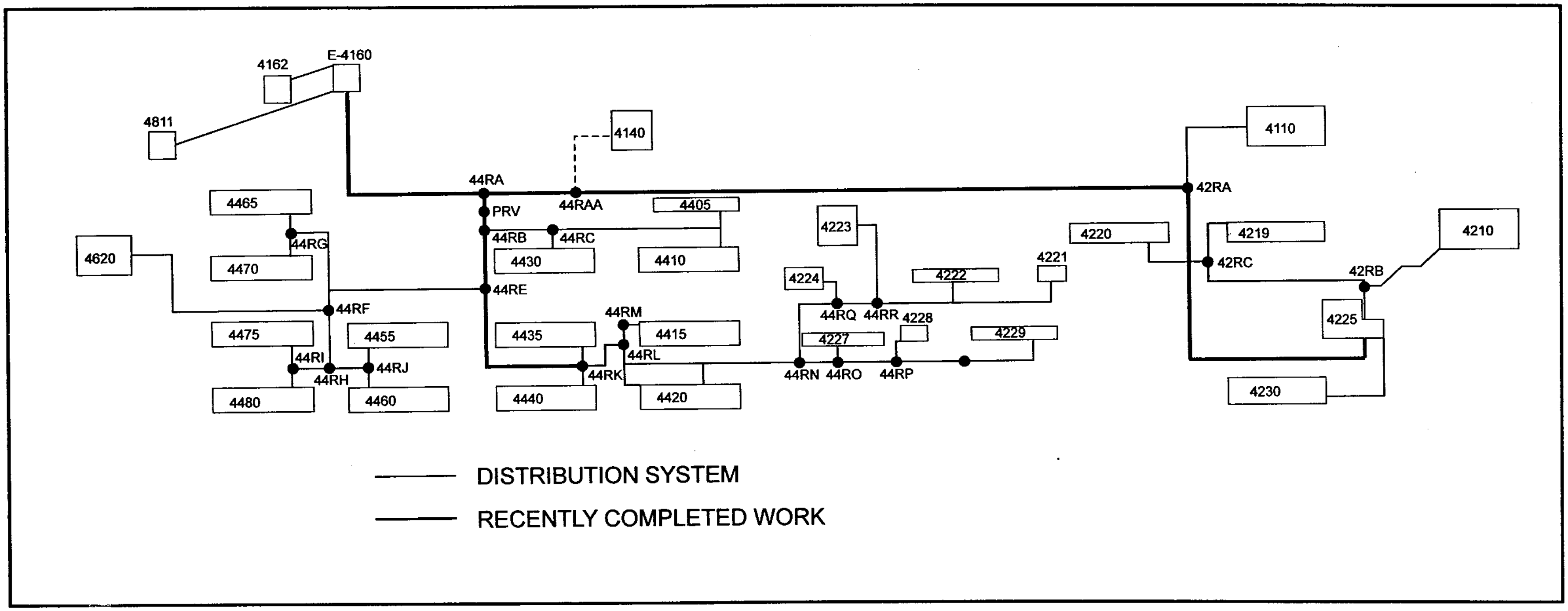

Figure 26. New E4000 area distribution system.

Table 17. CHP available pressures.

Line Size (in.)	CHP	Available Pressure (psig)
12	E5126	350
12	E3148	333
12	AEHA	337

Table 18. Alternative 3 LCC summary (consolidate CHPs E5126, E4160, and E4225).

Category	Costs	
Initial Investment		3,000,000
Energy costs:		
Electricity	562,902	
No. 2 oil	18,433,530	
Purchased steam	98,665,970	
Total energy		117,662,402
Recurring M&R/custodial		15,522,080
Major repair/replacement		3,329,920
LCC of all costs/benefits (net PW)		140,862,464

Table 19. Alternative 4 option 1 LCC summary (current cooling at E3510 and E3516).

Category	Costs	
Initial Investment		0
Energy costs:		
Electricity	69,094,110	
No. 2 oil	20,909,170	
Purchased steam	97,442,330	
Total energy		187,445,610
Recurring M&R/custodial		0
Major repair/replacement		58,217
LCC of all costs/benefits (net PW)		187,503,827

Table 20. Alternative 4 option 2 LCC summary (absorption chilling of E3510 and E3516).

Category	Costs	
Initial Investment		272,342
Energy costs:		
Electricity	68,787,500	
No. 2 oil	20,955,630	
Purchased steam	97,521,760	
Total energy		187,264,890
Recurring M&R/custodial		0
Major repair/replacement		0
LCC of all costs/benefits (net PW)		187,264,890

Table 21. Alternative 5 option 1 LCC summary (current cooling at E3081 and E3100).

Category	Costs	
Initial Investment		0
Energy costs:		
Electricity	68,094,110	
No. 2 oil	20,909,170	
Purchased steam	97,442,340	
Total energy		186,445,620
Recurring M&R/custodial		0
Major repair/replacement		644,501
LCC of all costs/benefits (net PW)		187,090,121

Table 22. Alternative 5 option 2 LCC summary (absorption chilling of E3081 and E3100).

Category	Costs	
Initial Investment		1,325,933
Energy costs:		
Electricity	65,879,160	
No. 2 oil	43,490,750	
Purchased steam	100,391,020	
Total energy		209,760,930
Recurring M&R/custodial		0
Major repair/replacement		0
LCC of all costs/benefits (net PW)		211,086,863

Table 23. Alternative 5 option 3 LCC summary (centrifugal chilling of the toxicology laboratory).

Category	Costs	
Initial Investment		581,986
Energy costs:		
Electricity	73,580,910	
No. 2 oil	20,909,170	
Purchased steam	17,975,140	
Total energy		112,465,220
Recurring M&R/custodial		0
Major repair/replacement		0
LCC of all costs/benefits (net PW)		113,047,206

Table 24. Alternative 5 option 4 LCC summary (absorption chilling of the toxicology laboratory).

Category	Costs	
Initial Investment		658,658
Energy costs:		
Electricity	70,221,990	
No. 2 oil	20,532,890	
Purchased steam	99,560,930	
Total energy		190,315,810
Recurring M&R/custodial		0
Major repair/replacement		0
LCC of all costs/benefits (net PW)		190,974,468

Table 25. Alternative 6 option 1 LCC summary (consolidate CHPs, new plant).

Category	Costs	
Initial Investment		12,275,590
Energy costs:		
Electricity	562,902	
No. 2 oil	18,027,010	
Purchased steam	98,665,970	
Total energy		117,255,882
Recurring M&R/custodial		13,018,890
Major repair/replacement		469,793
LCC of all costs/benefits (net PW)		143,020,155

Table 26. Alternative 6 option 2 LCC summary (consolidate CHPs, existing plant).

Category	Costs	
Initial Investment		6,152,758
Energy costs:		
Electricity	562,902	
No. 2 oil	18,027,010	
Purchased steam	98,665,970	
Total energy		117,255,882
Recurring M&R/custodial		13,333,100
Major repair/replacement		187,763
LCC of all costs/benefits (net PW)		136,929,503

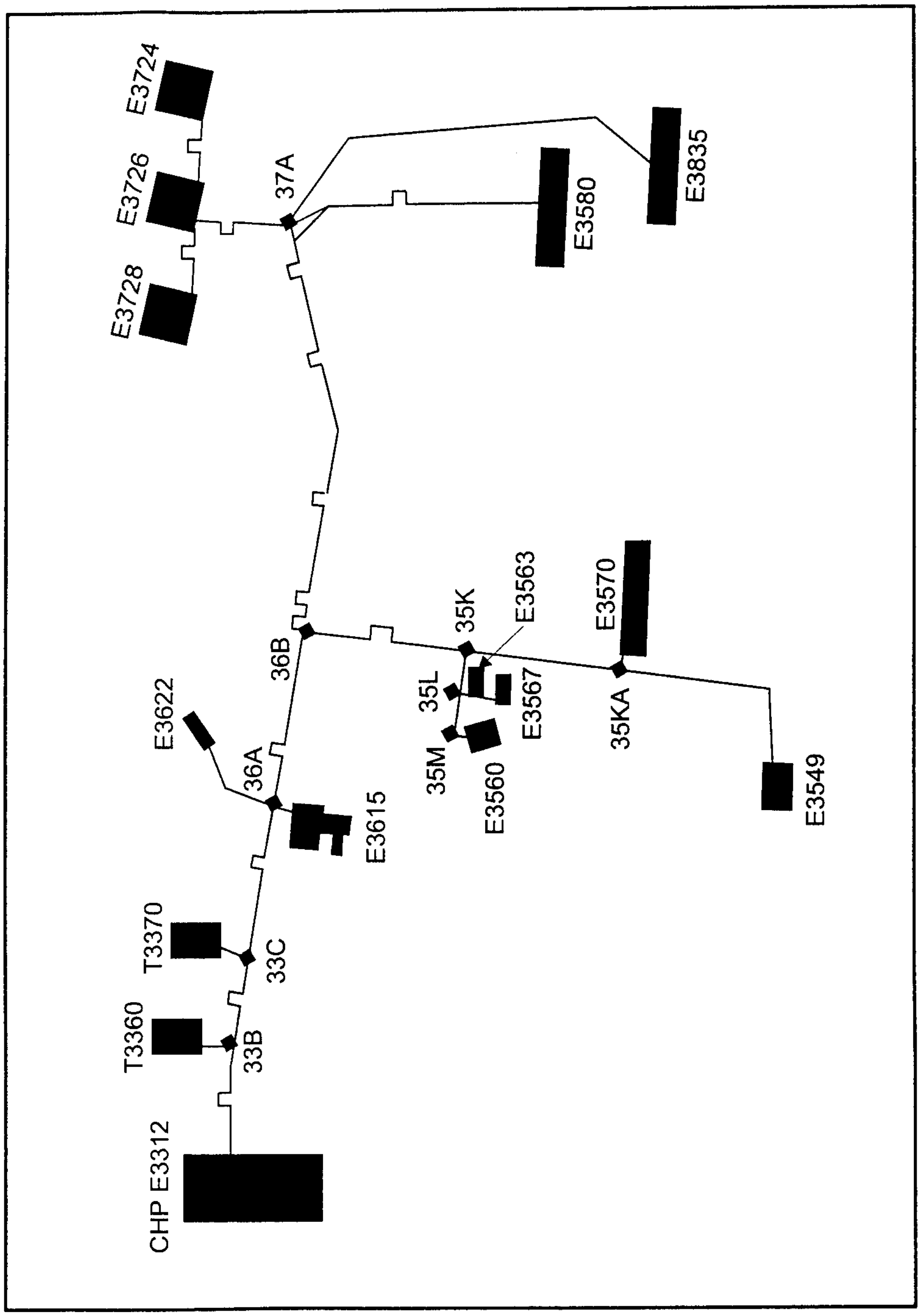

Figure 27. Existing condensate line to be replaced.

Table 27. Condensate energy available for return.

Month	Available Condensate (MBtu)
Jan	919
Feb	789
Mar	732
Apr	549
May	448
Jun	389
Jul	397
Aug	397
Sep	405
Oct	523
Nov	652
Dec	870

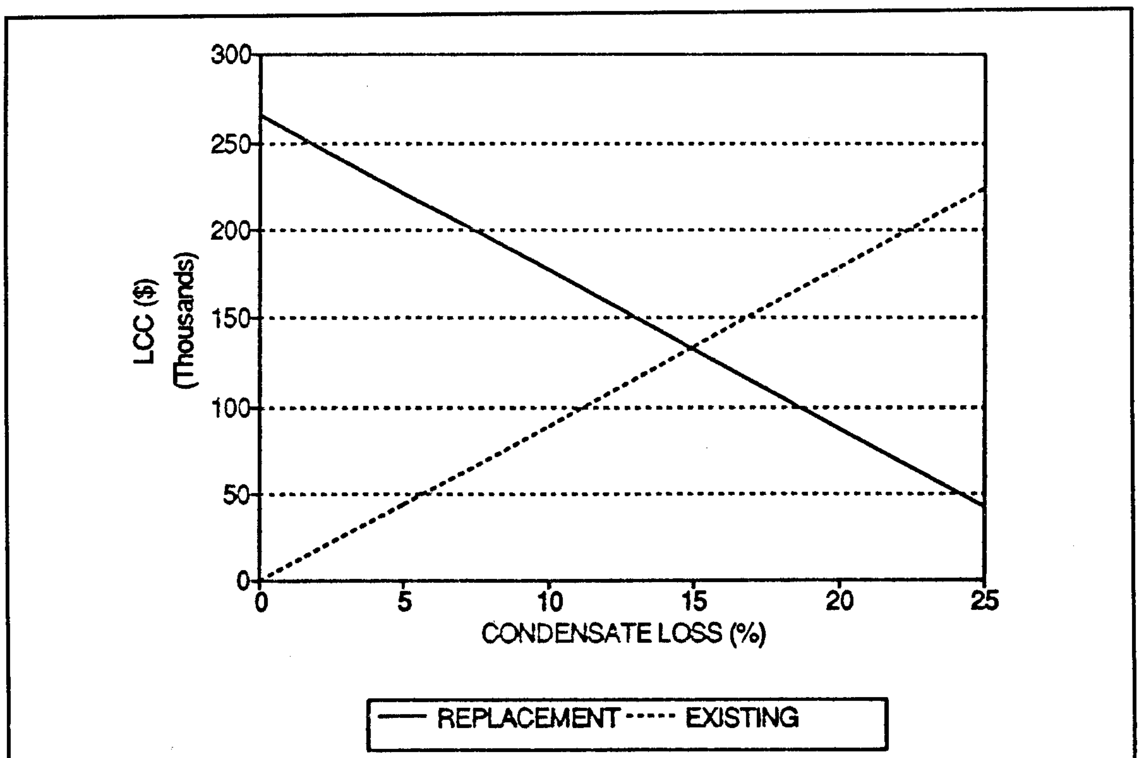

Figure 28. Alternative 3 LCC summary (consolidate CHPs E5126, E4160, and E4225).

Table 28. Alternative 7 LCC summary (fixing condensate leaks).

Category	Costs	
Initial Investment		270,063
Energy costs: No. 2 oil Total energy	-134,104	-134,104
Recurring M&R/custodial		-50,644
Major repair/replacement		0
LCC of all costs/benefits (net PW)		85,315

7 Alternative Description and Recommendations

This chapter provides more details on recommendations for selected modernization alternatives. The alternatives recommended for implementation are Alternative 3, Alternative 4 Option 2, and Alternative 6 Option 2.

Alternative 3

This option consolidates E5126, E4160, and E4225, and uses the existing building at E5126. For this alternative, E3312 is still in use. Boilers No. 1 through 5 in E5126 will be removed and two new package boilers rated at 70 MBtu/hr will be installed in their place.

Option 3 will require virtually the same initial heating plant improvements and plant upkeep as Option 2, which are listed in Tables 29 and 30 respectively.

Since E3312 will still supply its own steam as it does currently, the boilers in E5126 need only be sized to meet the peak loads experienced at E5126, E4160, E4225, and the toxicology laboratory, or a total of 139.6 MBtu/hr.

Figure 29 shows how steam would be supplied under this option with the WEP running. The WEP would produce 92 MBtu/hr, which would be supplied to E3312, E4160, E4225, and E5126. CHP E3312 would consume 46 MBtu/hr from the WEP and 24.9 MBtu/hr from E5126, respectively, to meet the steam requirements in the E3000 area. The E4000 area would receive all of its steam from the WEP (20.4 MBtu/hr). CHP E5126 would receive 25.6 MBtu/hr from the WEP; Boiler No. 1 (new 70 MBtu/hr boiler) would produce 70 MBtu/hr; and Boiler No. 2 (new 70 MBtu/hr boiler) would produce 68 MBtu/hr to meet the load in the E5000 area and the toxicology laboratory.

If the WEP should shut down, then boilers would be operated as shown in Figure 30. Boilers No. 1, 2, and 3 in E3312 would produce 15 MBtu/hr, 18 MBtu/hr, and 25 MBtu/hr respectively. Boilers No. 1 and 2 in E5126 would each produce 70 MBtu/hr, and Boiler No. 3 would produce 30 MBtu/hr. This would be enough to meet the combined peak of the E5000 area, E4000 area, and the toxicology laboratory, along with the remaining load of the E3000 Area, which together total 170 MBtu/hr.

This option will also require the implementation of Alternative 2.

Table 31 shows the combined life cycle costs for Alternative 4 Option 2 and Alternative 6 Option 2. Table 32 shows the energy savings if these two alternatives are implemented. Negative values represent an increase.

Alternative 4 Option 2

Alternative 4 Option 2 uses chilled water provided by a single stage steam absorption chiller to air-condition buildings E3510 and E3516. The absorption chiller is to be housed in a pre-engineered building and will supply chilled water via an underground chilled water distribution system.

The absorption chiller selected for this option is a 294-ton, single stage Trane absorption chiller model ABSC-02J. The nominal capacity of this unit is 294 tons, but the available capacity is actually 279 tons. This is the smallest unit available by Trane that can meet the estimated required size of 250 tons.

Figure 31 (Courtesy of the Trane Company) gives a side view of the absorption chiller along with the overall dimensions. This unit requires a clearance at one end of approximately 16 ft and a clearance at the other end of 3 ft. The clearance at the front and back should be at least 3 ft and 2 ft respectively.

The cooling tower selected for this unit is a Unilite Tower provided by A. Lombard & Company, Inc., which is a supplier for Baltimore Aircoil. The model is a single cell ULL-1212-15-12P3, designed to cool 840 gpm.

Figure 32 (Courtesy of the Trane Company) shows a basic schematic of the cooling tower piping. Figure 33 (Courtesy of the Trane Company) shows a schematic of the steam piping.

The full load steam consumption will be 19.6 lbs/hr*ton or 4900 lbs/hr at 12 psig saturated conditions, approximately 5.692 MBtu/hr. Figure 34 presents Normal monthly steam consumption of the absorption chiller. The two buildings are only air-conditioned from April to the end of October. The steam consumption is biggest in July with a total of 2000 MBtu.

During the summer, APG is able to purchase all of the steam it needs for the E5000 and E3000 areas from the WEP. However, APG does not have enough steam demand to reach the minimum purchase amount required by the WEP. As a result, this extra steam is released to the atmosphere by the WEP and APG still has to pay for the steam. The installation of this absorption chiller will be able to take advantage of this wasted steam. Therefore, part of the steam consumption by the absorption chiller will not increase the monthly steam bills because this steam is already being paid for, but is wasted.

Figure 35 separates the Normal monthly absorption chiller steam consumption into two portions. The portion labeled "free steam" represents the amount of steam that would normally be wasted. This portion of the absorption chiller steam will not increase APG's monthly steam bills. The portion labeled "added steam" represents the amount of absorption steam that will actually increase the steam bills. As a result, the absorption chiller steam consumption will only increase the WEP purchased steam by 1532 MBtu/yr and the APG generated steam by 344 MBtu/yr. The increase in APG generated steam will occur in October, when the WEP will not be able to meet the steam demand. The annual increase in steam costs, both purchased and generated, will be $6,319.

Figure 36 shows the effect of the absorption chiller on electrical consumption. This graph presents the monthly kWh used by the existing air-conditioning system and by the absorption system. The total use by the current system is 309,186 kWh/yr. The total use by the absorption system is 148,649 kWh/yr. The total electrical demand will also decrease from 1,514 kW for the current system to 337 kW for the absorption system. This translates into an electrical savings of $18,278/yr.

LCCID was used to determine the LCC of the current system versus the absorption system. The results showed that the LCC were close enough that either alternative could be pursued. LCCID does account for energy price increases over the 25-year life of the project. However, if the cost of purchased steam is allowed to increase above those estimated by LCCID, then the alternative may no longer be LCC effective. Figure 37 shows graphs of the winter and summer steam price predictions by LCCID based on DOE energy escalation values. The winter steam escalation values are the same as distillate oil escalation figures since WEP winter steam prices are based on No. 2 oil prices. The summer steam prices are escalated at the same rate as electricity since WEP summer steam prices are based on electricity prices.

Alternative 6 Option 2

Alternative 6 Option 2 consists of making E5126 the main CHP. Three new boilers each rated at 70 MBtu/hr will be installed in place of Boilers 1 through 5.

This project requires several plant auxiliary upgrades and worn out equipment demolition to implement the major components of the project. Table 29 summarizes these changes.

In addition to normal equipment maintenance, the plant will require replacement of worn out equipment project implementation. These items are shown in Table 30. The estimated year of replacement (shown in parenthesis) is based on typical expected component life. Actual replacement times will vary depending on equipment maintenance and operating conditions.

This plant would be operated much like the plant is operated now. During the periods when the WEP can supply the steam (May to September), E5126 would be on a standby basis. During the other months, the WEP will be able to supply enough steam to support plants E3312, E4160, and E4225. During these periods E5126 will supply its own steam. This will benefit APG by having all of its steam production in its most efficient plant. When the WEP needs to go off line, E5126 will provide steam for all plants by feeding steam back through the WEP steam line.

The boiler sizes for this alternative were determined by analyzing the peak loads of each distribution system plus the peak load for the proposed toxicology laboratory. These peak loads are determined for the design heating day for APG, which is 54 HDD. The peak loads for this design day are 88.2 MBtu/hr for E5126, 70.9 MBtu/hr for E3312, 15.3 MBtu/hr for E4160, 5.1 MBtu/hr for E4225, and 31 MBtu/hr for the toxicology laboratory for a total of 210.5 MBtu/hr. The boilers installed should be adequate to meet these peak loads. An additional 31 MBtu/hr will be required for the proposed AEHA Area.

Figure 38 shows where steam would be produced for the design day when the WEP is running. The WEP would produce 92 MBtu/hr, which would be enough to supply all of E3312, E4160, and E4225. Boiler #3 (a 70 MBtu/hr boiler) in E5126 would be required to produce 70 MBtu/hr and Boiler #2 would be required to produce 48.5 MBtu/hr. Together, these boilers and the WEP would produce enough to carry the entire load.

Figure 39 shows steam production when the WEP is down. Boilers No. 1, 2, and 3 (each 70 MBtu/hr boilers) would each produce 65 MBtu/hr and Boiler No. 4 (the current package boiler rated at 35 MBtu/hr) would produce 15.5 MBtu/hr and be able to swing with the load in case temperatures dropped further. The steam would be supplied back through the WEP line down to the other CHPs.

This option will require the implementation of Alternative 2, connection of the E4000 area to the WEP line.

Table 29. Initial central heating plant improvements.

- Replace/repair safety valves on boiler No. 6
- Remove boiler feedwater pumps; install new boiler feedwater pumps
- Remove the above-ground fuel oil tanks; add new above-ground fuel oil tanks
- Remove existing condensate pumps; add new condensate pumps
- Remove existing condensate receiver; add condensate receiver

Table 30. Plant upkeep after initial construction.

Economizer (2007)
Economizer (2015)
Safety Valve (2007)
Simplex Pump (2007)
Simplex Pump (2008)
Simplex Pump (2012)
Steel Tank (2007)
Steel Tank (2008)
Steel Tank (2012)
Condensate Pump (2012)
Condensate Receiver (2013)
Oil Pump (2008)
Flash Tank (2012)
Heat Exchanger (2015)
Sodium Zeolite Softener (2015)

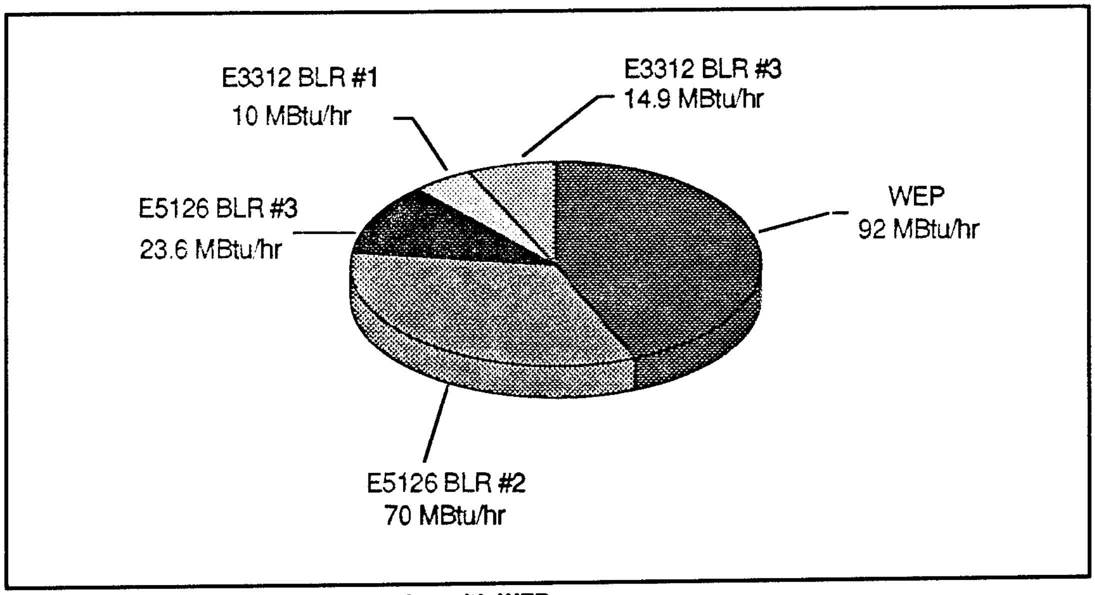

Figure 29. Alternative 3 boiler operation with WEP.

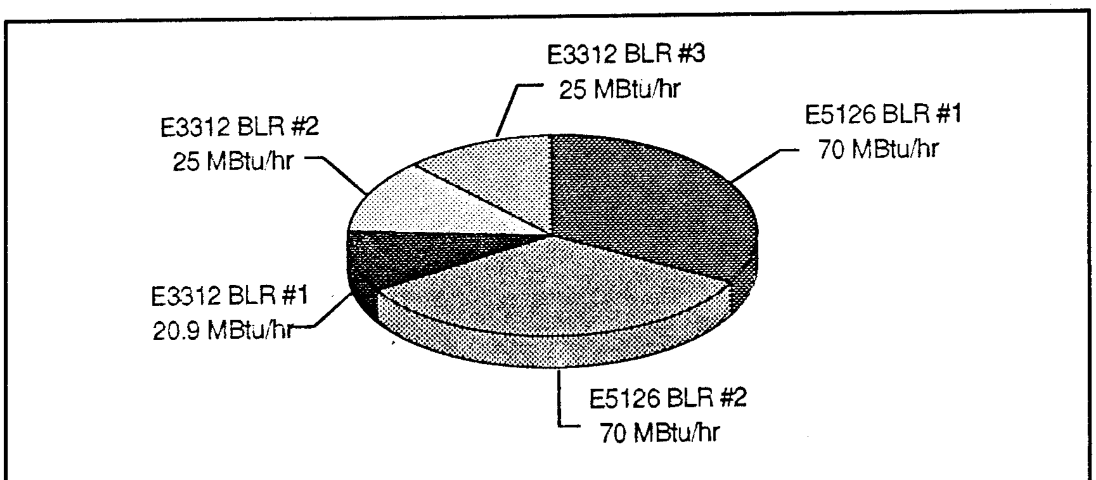

Figure 30. Alternative 3 boiler operation without WEP.

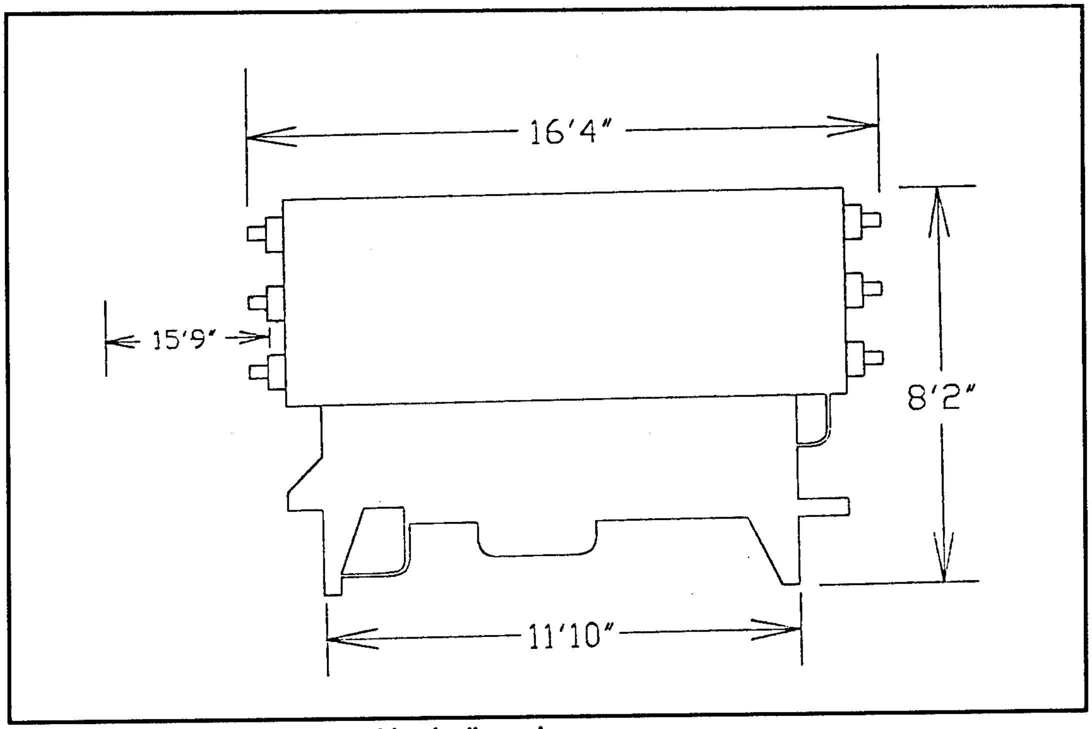

Figure 31. Absorption chiller roughing-in dimensions.

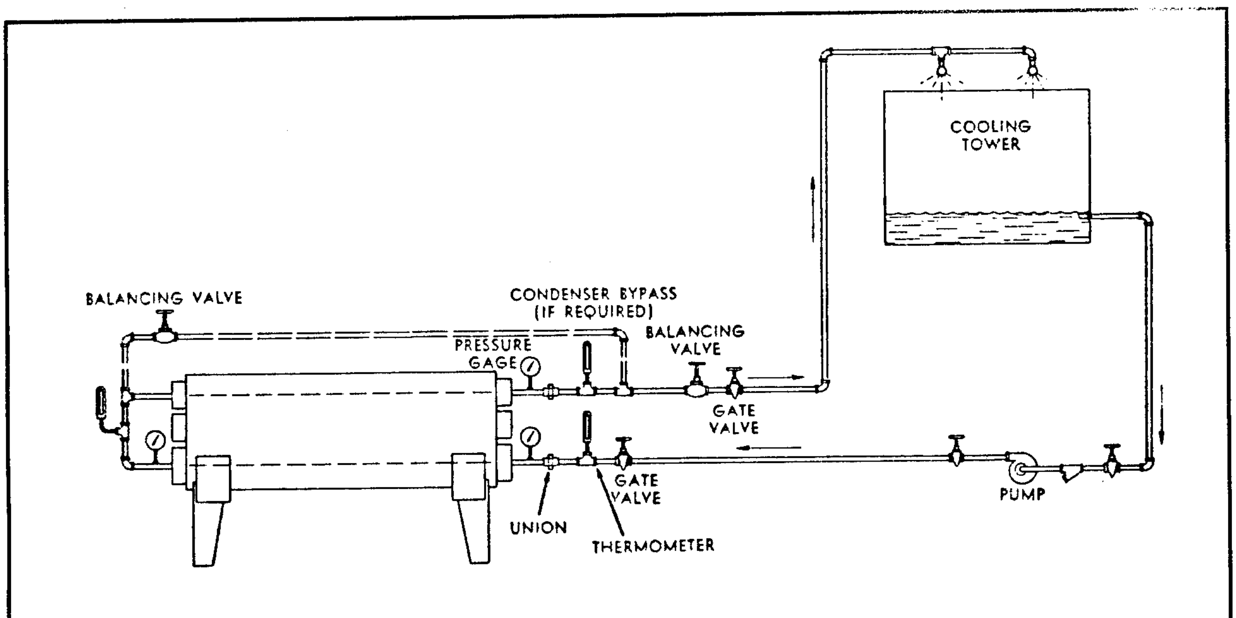

Figure 32. Cooling tower piping.

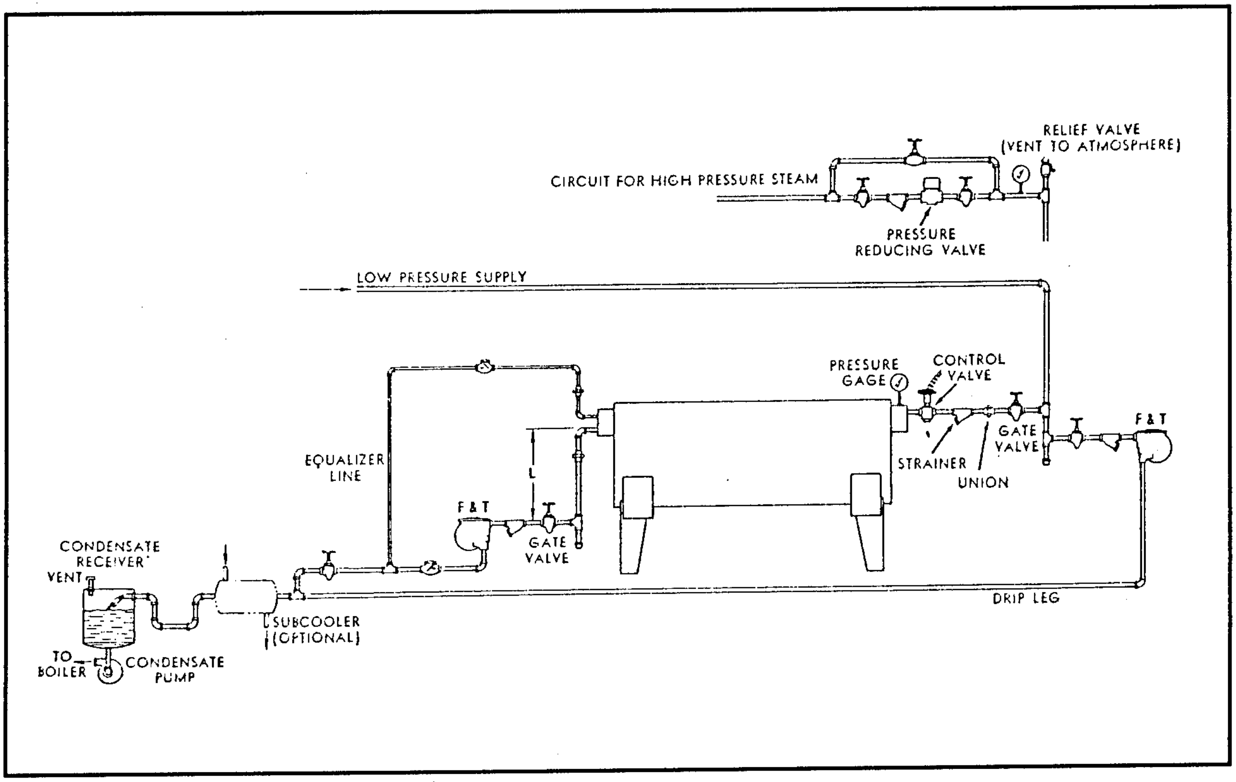

Figure 33. Absorption chiller steam piping.

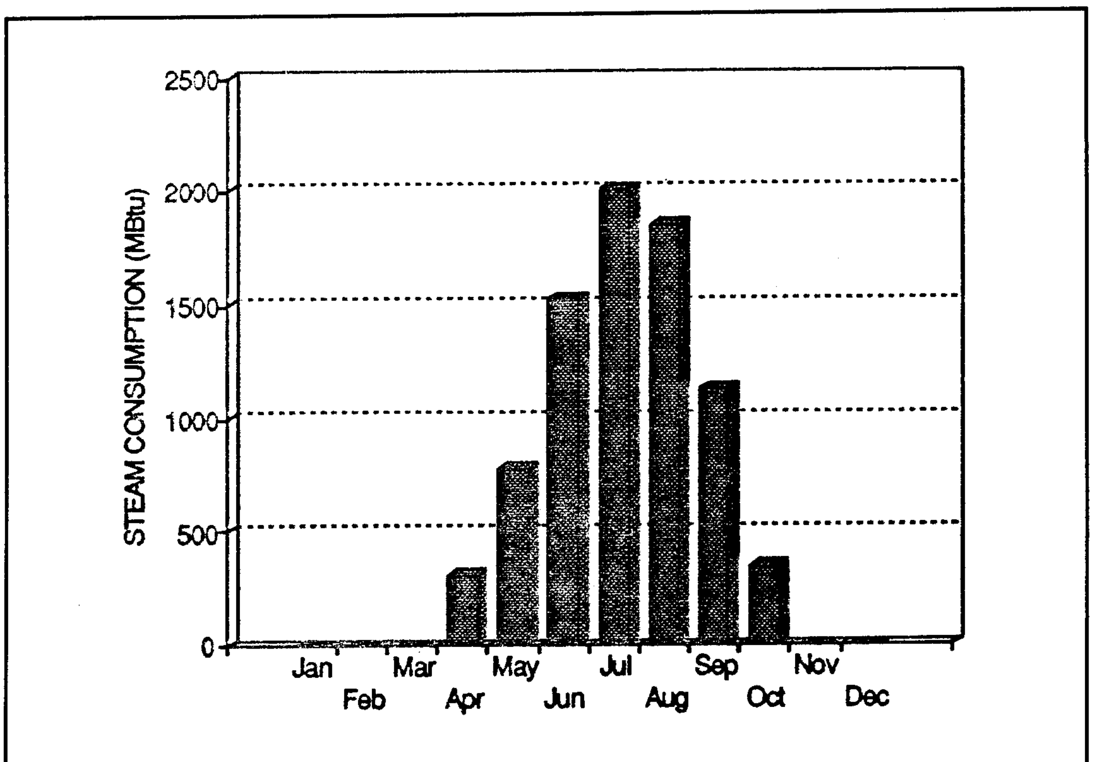

Figure 34. Projected absorption chiller steam consumption.

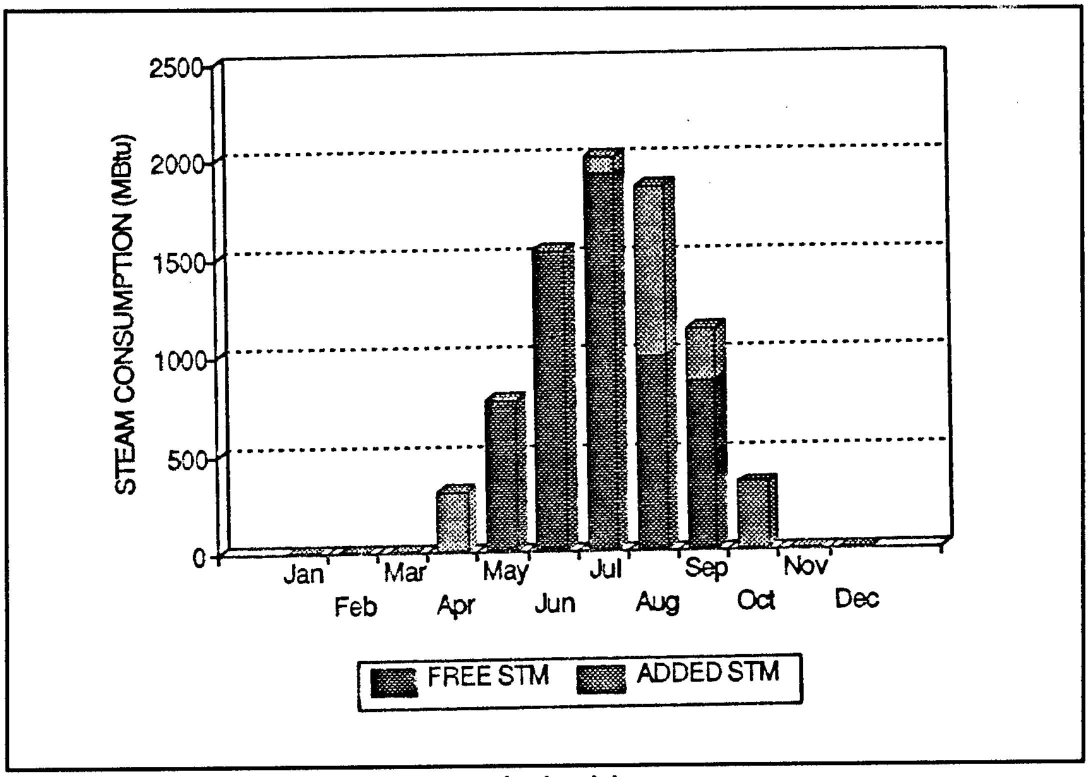

Figure 35. Absorption chiller steam consumption breakdown.

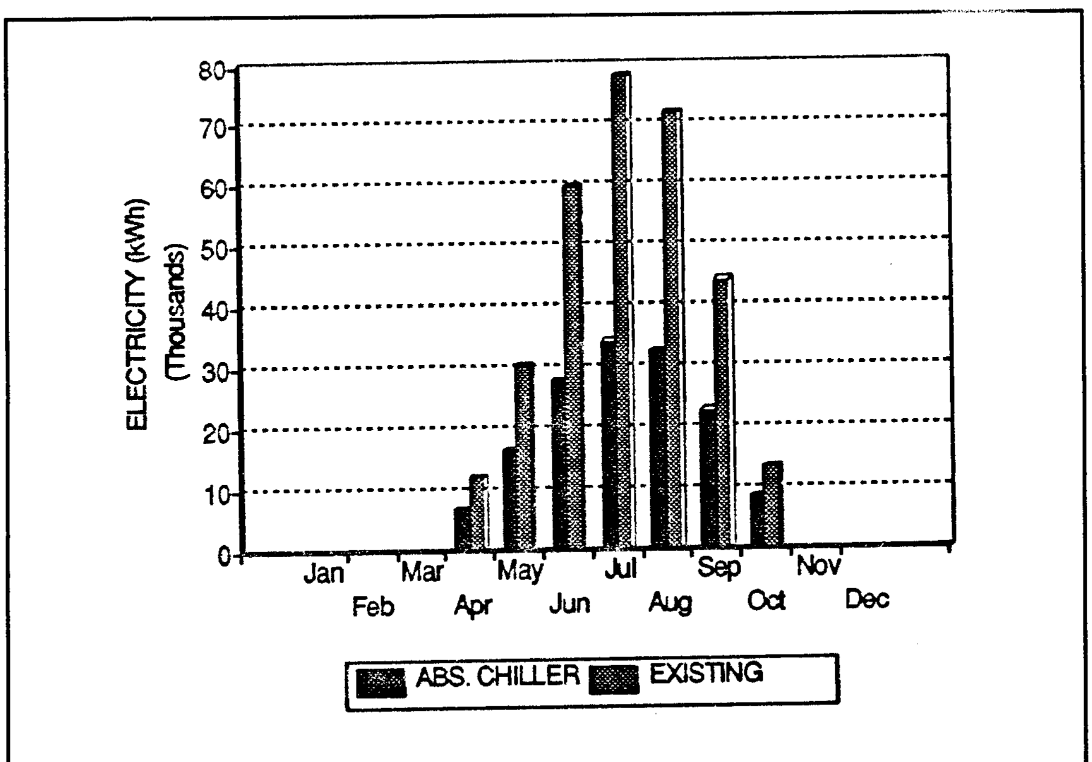

Figure 36. Absorption chiller electrical use.

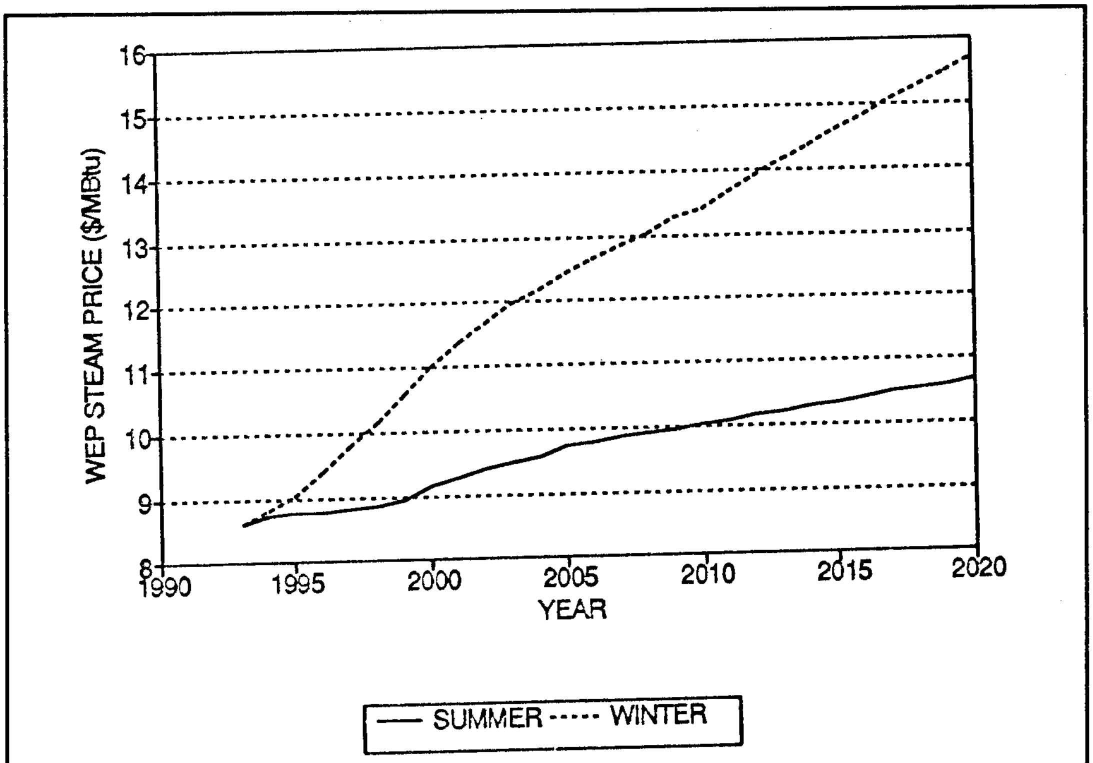

Figure 37. WEP escalated steam prices.

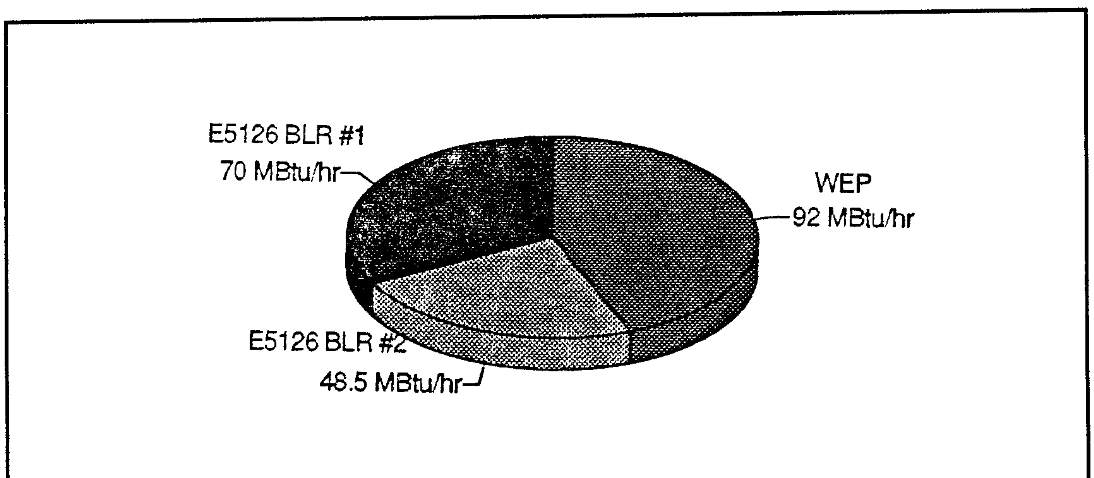

Figure 38. Alternative 6 option 2 boiler operation with WEP.

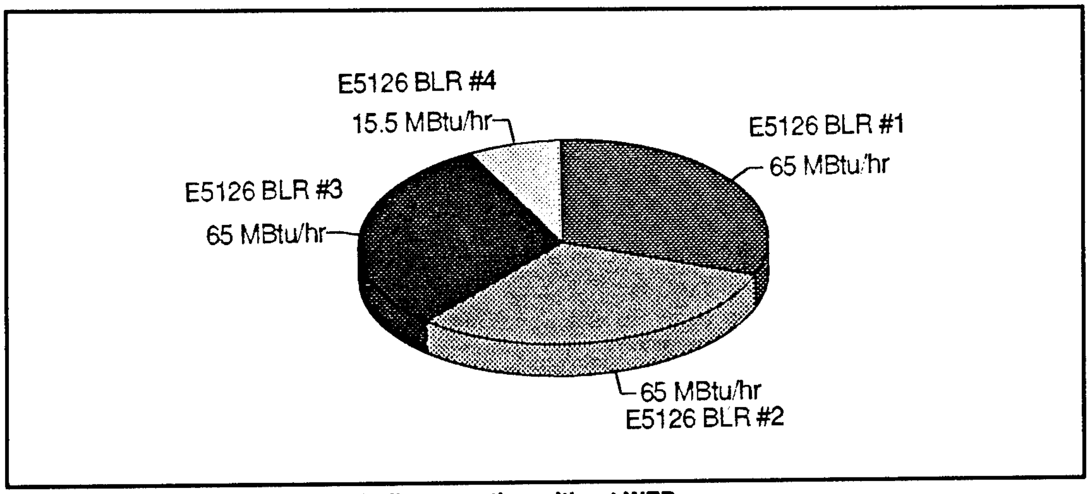

Figure 39. Alternative 6 option 2 boiler operation without WEP.

Table 31. Combined LCC summary.

Category	Costs	
Initial Investment		6,425,100
Energy costs:		
Electricity	744,774	
No. 2 oil	18,110,840	
Purchased steam	98,813,140	
Total energy		117,668,754
Recurring M&R/custodial		13,333,100
Major repair/replacement		187,763
LCC of all costs/benefits (net PW)		131,189,617

Table 32. Estimated energy and emissions savings.

Category	Savings
Electricity	688 MBTU/yr
No. 2 oil	29,365 MBTU/yr
Purchased steam	-5,838 MBTU/yr
NOx*	2.3 TPY
* Does not include NOx reduction from reduction inelectricity consumption.	

8 Conclusions and Recommendations

This study began with a general evaluation of the central heating plants and distribution system at the Aberdeen Proving Ground Edgewood Area. The four CHPs that service the main distribution networks at APG are: E5126 and E3312, which are interconnected through the WEP steam lines, and E4160 and E4225, which are independent plants. Several thermal energy problems were found that require attention.

Of the six watertube boilers in CHP E5126, the combustion controls for boilers 1 to 5 do not work; boiler operators adjust the air-to-fuel ratios by visual inspection. These boilers have no flame safe or purge controls, making inefficient and hazardous conditions likely. Boiler No. 6 is in good condition.

The APG steam distribution network is comprised of four main areas: the E5000, E3000, E4100, and E4200 areas. Most of the steam lines in the E5000 and E3000 areas are aboveground lines supported by metal or wooden stanchions, but some sections run underground. The aboveground steam lines are in fair condition; however portions of the insulation on these lines are badly degraded and some sections are missing insulation completely, which leads to excessive heat loss through pipe walls.

Condensate is returned in both the E3000 and E5000 areas. The condensate lines in the E3000 area are in poor condition. These lines have many leaks and in some areas have been abandoned. The steam lines in the E4100 and E4200 areas are mostly underground in a conduit system with manholes for access. The manholes in these areas are in very poor condition. Most manholes do not have sump pumps and the existing drains are clogged with debris. As a result, many manholes have filled with mud. Also, water is steaming in some of the manholes. This condition will reduce the remaining life of the steam and condensate lines in these areas.

Seven primary alternatives were identified for evaluation:

1. To maintain the status quo
2. To connect the E4000 area to WEP
3. To close the steam loop
4. To convert E3510 and E3516 to absorption chilling

5. To convert E3081, E3100, and the toxicology laboratory to absorption chilling
6. To consolidate the CHPs
7. To fix condensate leaks.

Alternative 7 should be implemented to decrease energy use and to prevent environmental problems that may result from chemical treatment leaking into groundwater. This alternative should be implemented regardless of the operating strategy selected from the other listed alternatives (1-6).

Various options within these alternatives were also analyzed. Baseline options were developed to compare the alternatives to the existing situation. Life cycle cost analyses were performed using the Life Cycle Cost in Design (LCCID) program.

Air quality regulations are the most significant environmental regulations that affected the analysis of alternatives for this study. The Baltimore area has been designated as a nonattainment area for ozone (O_3) and carbon monoxide (CO). The APG Edgewood area is located in Harford county, which is designated as a *severe* nonattainment area for O_3. Because of this ozone designation, APG is limited to an increase in nitrogen oxide emissions of 25 TPY to avoid BACT regulations that would require costly pollution control equipment.

Two cost-effective cooling technologies are appropriate to application at this site: absorption and centrifugal chilling. The three recommended alternatives to renovate and modernize the APG heating and distribution system were:

1. Alternative 4, Option 2 (use of absorption chilling at E3510 and E3516)
2. Alternative 5 (use of a centrifugal chilling in the toxicology laboratory)
3. Alternative 3 (combining the use of E5126 as the main CHP with the continued use of WEP as a steam supply source and closing the steam loop from E5126 to E3148).

Based on estimated LCC, this study concludes that Alternative 4 Option 2 should be selected for implementation because this alternative will promote energy conservation in two ways: (1) it will make use of steam produced by the WEP, which is currently being wasted because APG cannot use the minimum amount of steam required for purchase during the summer and (2) it will reduce the amount of electricity consumed by 160,537 kWh per year. This, added to the reduction in demand, will save $18,278 per year in electrical costs.

The absorption chiller will increase steam production by 1,876 MBTU per year, which will increase energy costs by $6,319 per year. This translates to a net energy savings of $11,959 per year or $298,975 over the life cycle of the project. Investment costs for this alternative are estimated to be $272,342.

Alternative 5 compared absorption chilling to centrifugal chilling of the toxicology laboratory. It was found that the LCC of centrifugal chilling would be more cost effective than absorption chilling, mostly because the absorption chiller would be located in building E3148 and require an extensive chilled water distribution system. The centrifugal chiller, which would be located at the toxicology laboratory, will require no lengthy underground distribution system.

Alternative 3 is also recommended for implementation. Under this alternative, E5126 and E3312 would become the main CHPs and the other CHPs would be placed on dry layaway. Two new boilers would be installed in E5126. Steam would be fed from E5126 to the Toxicology Laboratory through a new 12-in. line. The WEP would then supply steam to all plants except E5126, which would supply its own steam. If the WEP were to go off line, CHP E5126 would be able to feed steam back through the WEP steam lines to the other steam plants. This option also assumes that the E4000 area is connected to the WEP line.

Appendix A: Building Heatloads

BUILDING HEATING LOADS FOR E5000 AREA

							125 psi, sat	
BLDG #	TYPE	SQFTGE	BASE Btu/SQ FT/DAY	SLOPE Btu/SQ FT/DAY/HDD	BASE (MBtu/hr)	SLOPE (MBtu/hr/HDD)	BASE (lb/Hr)	SLOPE (lb/hr/HDD)
5026	W	20,536	35.7	36.1	0.031	0.031	25.65	25.93
5027	A	20,536	75.7	18.9	0.065	0.016	54.38	13.58
5100	P/M	29,900	91.5	31.4	0.114	0.039	95.71	32.84
5101	A	59,507	75.7	18.9	0.188	0.047	157.59	39.34
5103	C	10,538	147	14.2	0.065	0.006	54.19	5.23
5106	A	12,818	75.7	18.9	0.040	0.010	33.94	8.48
5116	P/M	264	91.5	31.4	0.001	0.000	0.85	0.29
5125	W	424	35.7	36.1	0.001	0.001	0.53	0.54
5135	W	2,513	35.7	36.1	0.004	0.004	3.14	3.17
5137	P/M	3,700	91.5	31.4	0.014	0.005	11.84	4.06
5140	W	12,360	35.7	36.1	0.018	0.019	15.44	15.61
5141	A	3,134	75.7	18.9	0.010	0.002	8.30	2.07
5146	P/M	1,354	91.5	31.4	0.005	0.002	4.33	1.49
5165	MED	15,368	254.4	24.3	0.163	0.016	136.77	13.06
5173	P/M	8,300	91.5	31.4	0.032	0.011	26.57	9.12
5175	P/M		91.5	31.4	0.000	0.000	0.00	0.00
5179	W	33,426	35.7	36.1	0.050	0.050	41.75	42.21
5180	P/M	4,443	91.5	31.4	0.017	0.006	14.22	4.88
5181	W	429	35.7	36.1	0.001	0.001	0.54	0.54
5183	A	11,141	75.7	18.9	0.035	0.009	29.50	7.37
5185	P/M	154,306	91.5	31.4	0.588	0.202	493.93	169.50
5188	W	22,790	35.7	36.1	0.034	0.034	28.46	28.78
5232	W	7,193	35.7	36.1	0.011	0.011	8.98	9.08
5234	A	11,807	75.7	18.9	0.037	0.009	31.27	7.81
5236	P/M	10,325	91.5	31.4	0.039	0.014	33.05	11.34
5244	W	12,360	35.7	36.1	0.018	0.019	15.44	15.61
5246	W	13,736	35.7	36.1	0.020	0.021	17.15	17.35
5265	W	26,042	35.7	36.1	0.039	0.039	32.52	32.89
5266	A	280	75.7	18.9	0.001	0.000	0.74	0.19
5307	P/M	3,523	91.5	31.4	0.013	0.005	11.28	3.87
5352	A	11,390	75.7	18.9	0.036	0.009	30.16	7.53
5354	T	9,210	75.7	18.9	0.029	0.007	24.39	6.09
5357	P/M	4,730	91.5	31.4	0.018	0.006	15.14	5.20
5360	P/M	23,545	91.5	31.4	0.090	0.031	75.37	25.86
5365	P/M	4,795	91.5	31.4	0.018	0.006	15.35	5.27
5422	A	5,807	75.7	18.9	0.018	0.005	15.38	3.84
5425	A	1,363	75.7	18.9	0.004	0.001	3.61	0.90
5427	P/M	6,683	91.5	31.4	0.025	0.009	21.39	7.34
5452	W	9,623	35.7	36.1	0.014	0.014	12.02	12.15
5554	P/M	2,480	91.5	31.4	0.009	0.003	7.94	2.72
5560	P/M	8,956	91.5	31.4	0.034	0.012	28.67	9.84
5590	P/M		91.5	31.4	0.000	0.000	0.00	0.00
5604	W	33,146	35.7	36.1	0.049	0.050	41.40	41.86
5609	W	2,053	35.7	36.1	0.003	0.003	2.56	2.59
5616	FH	4,826	73.7	32.4	0.015	0.007	12.44	5.47
5627	P/M	4,344	91.5	31.4	0.017	0.006	13.90	4.77
5648	P/M	6,802	91.5	31.4	0.026	0.009	21.77	7.47
5685	W	22,039	35.7	36.1	0.033	0.033	27.52	27.83
5695	P/M	17,438	91.5	31.4	0.066	0.023	55.82	19.16
5697	P/M	2,595	91.5	31.4	0.010	0.003	8.31	2.85
5703	W	41,072	35.7	36.1	0.061	0.062	51.29	51.87
5707	W	22,076	35.7	36.1	0.033	0.033	27.57	27.88
	TOTALS	758,026	3836.2	1551.9	2.263	0.958	1900.07	804.74

BUILDING HEATING LOADS FOR E3000 AREA

BLDG #	TYPE	SQFTGE	BASE Btu/SQ FT/DAY	SLOPE Btu/SQ FT/DAY/HDD	BASE (MBtu/hr)	SLOPE (MBtu/hr/HDD)	125 PSI, SAT BASE (lb/hr)	125 PSI, SAT SLOPE (lb/hr/HDD)
3081	MED	64,688	254.4	24.3	0.686	0.065	575.70	54.99
3100	P/M	76,490	91.5	31.4	0.292	0.100	244.84	84.02
3148	W	3,521	35.7	36.1	0.005	0.005	4.40	4.45
3160	MED	23,380	254.4	24.3	0.248	0.024	208.08	19.88
3161	P/M	5,725	91.5	31.4	0.022	0.007	18.33	6.29
3165	MED	1,480	254.4	24.3	0.016	0.001	13.17	1.26
3220	P/M	41,860	91.5	31.4	0.160	0.055	133.99	45.98
3222	P/M	32,901	91.5	31.4	0.125	0.043	105.31	36.14
3224	P/M	5,981	91.5	31.4	0.023	0.008	19.14	6.57
3226	P/M	18,834	91.5	31.4	0.072	0.025	60.29	20.69
3228	P/M	4,742	91.5	31.4	0.018	0.006	15.18	5.21
3230	P/M	5,850	91.5	31.4	0.022	0.008	18.73	6.43
3232	P/M	4,799	91.5	31.4	0.018	0.006	15.36	5.27
3234	P/M	5,709	91.5	31.4	0.022	0.007	18.27	6.27
3240	A	4,648	75.7	18.9	0.015	0.004	12.31	3.07
3242	A	2,264	75.7	18.9	0.007	0.002	6.00	1.50
3244	MED	9,206	254.4	24.3	0.098	0.009	81.93	7.83
3265	P/M	5,509	91.5	31.4	0.021	0.007	17.63	6.05
3266	P/M	5,397	91.5	31.4	0.021	0.007	17.28	5.93
3320	A	6,550	75.7	18.9	0.021	0.005	17.35	4.33
3325	P/M	452	91.5	31.4	0.002	0.001	1.45	0.50
3326	P/M	574	91.5	31.4	0.002	0.001	1.84	0.63
3328	P/M	516	91.5	31.4	0.002	0.001	1.65	0.57
3329	P/M	551	91.5	31.4	0.002	0.001	1.76	0.61
3330	A	121,335	75.7	18.9	0.383	0.096	321.32	80.22
3331	A	41,580	75.7	18.9	0.131	0.033	110.11	27.49
3334	W	400	35.7	36.1	0.001	0.001	0.50	0.51
3348	P/M	1,262	91.5	31.4	0.005	0.002	4.04	1.39
3360	MED	3,588	254.4	24.3	0.038	0.004	31.93	3.05
3370	P/M	2,154	91.5	31.4	0.008	0.003	6.89	2.37
3500	W	3,471	35.7	36.1	0.005	0.005	4.33	4.38
3510	P/M	22,590	91.5	31.4	0.086	0.030	72.31	24.81
3514	MED	4,416	254.4	24.3	0.047	0.004	39.30	3.75
3516	P/M	62,109	91.5	31.4	0.237	0.081	198.81	68.22
3517	W	1,001	35.7	36.1	0.001	0.002	1.25	1.26
3518	W	1,015	35.7	36.1	0.002	0.002	1.27	1.28
3519	W	1,001	35.7	36.1	0.001	0.002	1.25	1.26
3521	W	1,063	35.7	36.1	0.002	0.002	1.33	1.34
3523	W	1,078	35.7	36.1	0.002	0.002	1.35	1.36
3525	W	2,175	35.7	36.1	0.003	0.003	2.72	2.75
3540	P/M	1,922	91.5	31.4	0.007	0.003	6.15	2.11
3542	P/M	1,146	91.5	31.4	0.004	0.001	3.67	1.26
3544	P/M	1,183	91.5	31.4	0.005	0.002	3.79	1.30
3546	P/M	2,574	91.5	31.4	0.010	0.003	8.24	2.83
3549	P/M	140,178	91.5	31.4	0.534	0.183	448.70	153.98
3550	P/M	5,203	91.5	31.4	0.020	0.007	16.65	5.72
3552	P/M	2,584	91.5	31.4	0.010	0.003	8.27	2.84
3560	P/M	2,160	91.5	31.4	0.008	0.003	6.91	2.37
3563	W	1,025	35.7	36.1	0.002	0.002	1.28	1.29
3566	W	1,645	35.7	36.1	0.002	0.002	2.05	2.08
3567	P/M	390	91.5	31.4	0.001	0.001	1.25	0.43
3570	P/M	13,498	91.5	31.4	0.051	0.018	43.21	14.83
3580	W	7,420	35.7	36.1	0.011	0.011	9.27	9.37
3615	P/M	9,282	91.5	31.4	0.035	0.012	29.71	10.20
3724	P/M	4,355	91.5	31.4	0.017	0.006	13.94	4.78
3726	P/M	6,570	91.5	31.4	0.025	0.009	21.03	7.22
3728	P/M	2,596	91.5	31.4	0.010	0.003	8.31	2.85
	TOTALS	805,596	5444.3	1741.1	3.622	0.935	3041.14	785.36

BUILDING HEATING LOADS FOR E4160 PLANT

BLDG #	TYPE	SQFTGE	BASE Btu/SQ FT/DAY	SLOPE Btu/SQ FT/DAY/HDD	BASE (MBtu/hr)	SLOPE (MBtu/hr/HDD)	20 PSI, SAT BASE (lb/hr)	20 PSI, SAT SLOPE (lb/hr/HDD)
4140	REC	11986	231.5	5.25	0.116	0.003	99.99	2.27
4162	REC	3341	231.5	5.25	0.032	0.001	27.87	0.63
4221	A	4878	75.7	18.9	0.015	0.004	13.31	3.32
4222	B2	31908	81.9	7.4	0.109	0.010	94.17	8.51
4223	A	9678	75.7	18.9	0.031	0.008	26.40	6.59
4224	A	4878	75.7	18.9	0.015	0.004	13.31	3.32
4227	B2	31908	81.9	7.4	0.109	0.010	94.17	8.51
4228	A	4878	75.7	18.9	0.015	0.004	13.31	3.32
4229	B2	31908	81.9	7.4	0.109	0.010	94.17	8.51
4405	A	6853	75.7	18.9	0.022	0.005	18.69	4.67
4410	B1	8176	130.5	15.9	0.044	0.005	38.45	4.68
4415	B1	12150	130.5	15.9	0.066	0.008	57.14	6.96
4420	B1	8805	75.7	18.9	0.028	0.007	24.02	6.00
4430	B1	16648	75.7	18.9	0.053	0.013	45.41	11.34
4435	B1	15028	130.5	15.9	0.082	0.010	70.67	8.61
4440	B1	14271	130.5	15.9	0.078	0.009	67.11	8.18
4455	A	16643	75.7	18.9	0.052	0.013	45.40	11.33
4460	B1	16648	75.7	18.9	0.053	0.013	45.41	11.34
4465	B1	10655	35.7	36.1	0.016	0.016	13.71	13.86
4470	B1	16655	75.7	18.9	0.053	0.013	45.43	11.34
4475	B1	16655	130.5	15.9	0.091	0.011	78.32	9.54
4480	B1	17678	130.5	15.9	0.096	0.012	83.13	10.13
4620	FH	13481	73.7	32.4	0.041	0.018	35.80	15.74
4810	GYM	5276	73.7	32.4	0.016	0.007	14.01	6.16
		TOTALS	2431.8	418	1.341	0.214	1159.38	184.86

BUILDING HEATING LOADS FOR E4225 SYSTEM

BLDG #	TYPE	SQFTGE	BASE Btu/SQ FT/DAY	SLOPE Btu/SQ FT/DAY/HDD	BASE (MBtu/hr)	SLOPE (MBtu/hr/HDD)	20 PSI, SAT BASE (lb/hr)	20 PSI, SAT SLOPE (lb/hr/HDD)
4210	GYM	21,327	73.7	32.4	0.065	0.029	56.64	24.90
4215	B1	40,650	130.5	10.5	0.221	0.018	191.16	15.42
4220	A	12,135	75.7	7.0	0.038	0.004	33.10	3.07
4225	DIN	15,136	241.9	0.0	0.153	0.000	131.94	0.00
4230	B1	40,650	130.5	10.5	0.221	0.018	191.16	15.42
		TOTALS	652.3	60.48	0.698	0.068	603.99	58.82

Appendix B: SHDP Models and Results

10/12/93 09:44
E5126

SOLUTION COMPLETED IN 10 ITERATIONS
SOME NODES MAY NOT BE BALANCED

```
*** PROBLEM SUMMARY ***
89 NODES IN THE SYSTEM
89 PIPES IN THE SYSTEM
 0 VALVES OR REGULATORS
 0 FAULTY TRAPS
 0 VAULTS IN THE SYSTEM
 0 UNKNOWN PARAMETERS
88 UNKNOWN PRESSURES
 1 UNKNOWN FLOWS
```

COMPUTED NODE DATA

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESIDUAL (lbm/hr)
E5126	125.00	82456.9?	-1129.2	.0	220015.5	352.9	.77
51A	124.94?	.0	-418.0	.0	81425.3	352.8	-.69
51B	124.63?	.0	-121.8	.0	23713.2	352.7	.08
E5116	124.59?	-19.8	-12.9	1390.5	2510.9	352.6	-.01
E5100	124.45?	-2230.3	-42.5	156632.1	8269.4	352.6	-.10
51C	124.81?	.0	-174.6	.0	33998.0	352.8	.10
E5106	124.42?	-585.1	-23.0	41091.1	4479.3	352.5	-.02
51D	124.79?	.0	-109.8	.0	21394.4	352.7	-.20
E5103	124.37?	-394.1	-46.0	27677.3	8960.7	352.5	-.05
51E	122.18?	.0	-257.0	.0	49818.2	351.3	-.03
E5137	121.71?	-275.7	-3.5	19362.2	680.1	351.0	-.01
E5135	121.30?	-209.2	-10.5	14691.9	2040.1	350.8	-.01
51F	109.19?	.0	-52.4	.0	9911.0	343.7	.01
E5232	106.85?	-599.2	-3.3	42081.3	618.9	342.2	.00
51G	100.67?	.0	-97.5	.0	18097.4	338.3	.01
E5234	98.64?	-539.0	-3.2	37853.5	596.8	337.0	.00
E5236	93.56?	-770.1	-66.6	54083.5	12176.4	333.6	-.01
51H	123.23?	.0	-334.6	.0	64992.1	351.9	-.02
51I	121.27?	.0	-54.6	.0	10559.6	350.8	-.01
E5140	120.90?	-1030.0	-1.5	72336.0	297.3	350.6	.01
E5141	121.10?	-142.8	-25.0	10028.7	4840.1	350.7	-.02
52A	122.26?	.0	-290.9	.0	56390.2	351.3	.12
E5246	122.18?	-1144.8	-13.7	80398.3	2662.2	351.3	.03
52B	121.52?	.0	-936.9	.0	181387.2	350.9	.50
52C	121.49?	.0	-356.5	.0	69022.7	350.9	-.08
E5422	121.29?	-265.0	-42.2	18610.7	8164.4	350.8	-.03
E5265	121.18?	-2170.3	-79.4	152418.3	15362.6	350.7	-.14
E5266	121.18?	-13.1	-5.6	920.0	1088.0	350.7	.04
51J	124.94?	.0	-317.0	.0	61766.7	352.8	.27
E5165	124.76?	-985.7	-162.2	69224.9	31584.6	352.7	-.26
51K	123.25?	.0	-104.6	.0	20321.7	351.9	.67
E5175	123.25?	.0	-6.0	.0	1166.1	351.9	-.62
E5179	121.03?	-2785.4	-127.4	195616.3	24641.8	350.6	-.03
51L	122.85?	.0	-1414.4	.0	274516.4	351.7	.25
51M	118.59?	.0	-301.9	.0	58125.0	349.2	.04
E5101	118.45?	-2714.7	-11.5	190651.0	2212.9	349.2	-.02
E5146	118.58?	-101.2	-25.1	7107.2	4841.4	349.2	-.07
51N	115.53?	.0	-126.2	.0	24154.7	347.5	-.01
51O	115.00?	.0	-99.9	.0	19101.4	347.1	.13
E5181	115.53?	-35.6	-1.3	2500.2	245.5	347.5	-.01
E5180	110.43?	-331.4	-15.1	23273.9	2870.1	344.4	-.01
E5183	114.98?	-508.5	-13.5	35711.5	2581.1	347.1	-.10
51P	112.92?	.0	-82.8	.0	15771.0	345.9	-.03
E5027	112.26?	-937.1	-3.0	65811.7	573.6	345.5	-.01
E5026	97.85?	-1711.1	-17.4	120169.1	3212.7	336.5	-.01
E5185	121.72?	-11511.4	-1466.2	808435.8	283968.2	351.0	.09
51R	121.23?	.0	-1230.9	.0	238183.4	350.7	.18
E5188	120.99?	-1899.2	-182.7	133379.2	35331.6	350.6	-.11
56A	121.16?	.0	-459.2	.0	88843.6	350.7	7.89
E5604	121.09?	-2762.3	-10.5	193994.0	2036.9	350.7	-.05
56B	121.13?	.0	-75.0	.0	14514.8	350.7	.12
E5609	121.12?	-170.9	-8.8	12002.2	1699.5	350.7	-.11
56C	121.15?	.0	-1521.1	.0	294286.1	350.7	-11.80
56D	120.80?	.0	-1699.0	.0	328502.1	350.5	.08

COMPUTED NODE DATA

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESIDUAL (lbm/hr)
56E	120.69?	.0	-432.1	.0	83535.2	350.4	-.10
E5648	119.41?	-507.3	-151.3	35627.2	29177.2	349.7	-.03
57A	120.38?	.0	-621.1	.0	119989.7	350.3	-.08
E5707	120.35?	-1839.8	-5.8	129207.6	1117.3	350.2	-.05
E5703	116.47?	-3422.8	-183.1	240380.3	35123.1	348.0	-.04
56F	121.14?	.0	-3936.4	.0	761578.4	350.7	2.51
56G	121.15?	.0	-157.4	.0	30458.6	350.7	5.53
56H	121.16?	.0	-157.4	.0	30459.3	350.7	-2.02
56I	121.16?	.0	-201.6	.0	39009.8	350.7	-2.78
E5365	121.15?	-357.9	-9.8	25135.0	1886.6	350.7	-.02
56J	121.17?	.0	-703.8	.0	136171.4	350.7	.53
55A	108.18?	.0	-927.5	.0	174964.6	343.0	-.28
E5560	107.83?	-668.3	-3.0	46934.1	566.9	342.8	-.01
E5307	120.90?	-262.9	-98.4	18463.2	19024.6	350.6	-.04
E5590	108.18?	.0	-108.8	.0	20530.5	343.0	.29
54A	95.27?	.0	-1122.6	.0	205940.8	334.8	.12
54B	95.09?	.0	-443.6	.0	81344.9	334.6	-.04
E5425	95.08?	-62.1	-5.6	4361.2	1022.1	334.6	-.05
E5427	94.50?	-498.5	-70.7	35009.2	12951.1	334.2	-.03
54C	93.99?	.0	-663.4	.0	121337.3	333.9	.03
E5452	93.86?	-801.8	-7.8	56309.7	1432.3	333.8	-.01
54D	90.78?	.0	-632.0	.0	114733.4	331.7	.08
E5360	90.22?	-1756.3	-33.8	123343.5	6132.5	331.3	-.01
E5357	90.11?	-353.1	-12.9	24797.9	2341.4	331.2	-.03
E5352	90.68?	-519.7	-93.8	36498.1	17031.2	331.6	-.10
E5354	90.66?	-420.3	-21.0	29517.3	3816.8	331.6	-.02
56K	120.36?	.0	-3474.0	.0	671149.3	350.2	-.36
E5685	119.29?	-1836.4	-16.7	128968.8	3214.8	349.6	.00
E5695	120.33?	-1301.2	-194.8	91382.2	37621.9	350.2	-.04
E5697	119.91?	-193.5	-98.1	13589.3	18941.9	350.0	-.04
E5125	125.00?	-35.6	-7.9	2500.2	1537.4	352.9	.03
E5173	122.62?	-619.4	-3.0	43499.9	580.5	351.5	-.01
51KA	122.75?	.0	-153.6	.0	29797.6	351.6	-.04
51HA	122.92?	.0	-175.3	.0	34021.8	351.7	-.12
E5244	122.18?	-1030.0	-3.1	72336.0	598.3	351.3	.00

COMPUTED PIPE FLOWS AND PARAMETERS

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
E5126	51A		4177.0	527.63	458076.8	8.00	1.62E+5	1.82E-2
51A	51B		2427.2	132.81	115403.8	4.00	1.88E+5	1.99E-2
51B	E5116		32.7	25.79	22395.9	1.00	1.01E+4	3.46E-2
51B	E5100		2272.7	84.97	73826.2	4.00	1.76E+5	2.00E-2
51A	51C		1332.5	175.47	152357.7	4.00	1.03E+5	2.10E-2
51C	E5106		608.1	46.03	39994.6	2.00	9.42E+4	2.36E-2
51C	51D		549.7	127.61	110790.9	4.00	4.26E+4	2.37E-2
51D	E5103		440.1	92.08	79984.5	2.00	6.82E+4	2.43E-2
E5126	51E		2887.3	442.82	385934.8	3.00	2.98E+5	2.04E-2
51E	E5137		279.2	7.02	6123.1	1.00	8.65E+4	2.72E-2
51E	E5135		219.7	21.08	18362.2	1.00	6.81E+4	2.76E-2
51E	51F		2131.4	43.08	41155.1	1.50	4.40E+5	2.36E-2

51F	E5232	602.5	6.58	5958.9	1.00	1.87E+5	2.65E-2
51F	51G	1476.4	55.20	50329.8	1.50	3.05E+5	2.38E-2
51G	E5234	542.2	6.46	5853.2	1.00	1.68E+5	2.65E-2
51G	E5236	836.7	133.28	118733.8	1.50	1.73E+5	2.42E-2
E5126	51H	23287.6	512.47	449993.7	8.00	9.02E+5	1.62E-2
51H	51I	1253.9	56.02	49012.4	2.00	1.94E+5	2.26E-2
51I	E5140	1031.5	3.08	2720.4	1.50	2.13E+5	2.40E-2
51I	E5141	167.8	50.04	43534.9	1.50	3.47E+4	2.73E-2
51H	51HA	21699.1	100.79	88355.4	8.00	8.40E+5	1.62E-2
52A	E5246	1158.6	27.47	23892.1	3.00	1.20E+5	2.16E-2
52A	52B	19041.3	310.68	271837.3	8.00	7.37E+5	1.63E-2
52B	52C	2931.9	481.13	418479.2	8.00	1.14E+5	1.91E-2
52C	E5422	307.2	84.38	73401.9	2.00	4.76E+4	2.52E-2
52C	E5265	2268.3	147.55	128439.8	4.00	1.76E+5	2.00E-2
E5265	E5266	18.8	11.25	9783.0	1.25	4.65E+3	4.04E-2
E5126	51J	5264.3	158.83	137916.8	6.00	2.72E+5	1.81E-2
51J	E5165	1147.6	324.35	281622.7	4.00	8.89E+4	2.13E-2
51J	51K	3799.4	150.91	131859.0	3.00	3.92E+5	2.02E-2
51K	E5175	5.4	12.01	10434.2	1.50	1.11E+3	5.70E-2
51K	51KA	3688.7	46.34	40490.9	3.00	3.81E+5	2.02E-2
E5126	51L	45666.8	600.88	533416.3	10.00	1.41E+6	1.53E-2
51L	51M	3154.4	530.46	463695.3	3.00	3.26E+5	2.04E-2
51M	E5101	2726.2	22.99	20077.1	3.00	2.82E+5	2.05E-2
51M	E5146	126.3	50.29	43810.0	2.00	1.96E+4	2.88E-2
51L	51N	3882.9	232.07	205911.1	3.00	4.01E+5	2.02E-2
51N	51O	3719.8	17.73	15719.7	3.00	3.84E+5	2.02E-2
51N	E5181	36.9	2.56	2238.2	1.00	1.14E+4	3.39E-2
51O	E5180	346.5	30.29	26711.0	1.00	1.07E+5	2.69E-2
51O	E5183	521.9	27.00	23566.9	3.00	5.39E+4	2.35E-2
51O	51P	2751.4	124.76	109757.8	3.00	2.84E+5	2.05E-2
51P	E5027	940.1	6.03	5352.7	1.50	1.94E+5	2.41E-2
51P	E5026	1728.5	34.82	34294.5	1.50	3.57E+5	2.37E-2
51L	E5185	37214.8	1465.47	1279301.0	10.00	1.15E+6	1.54E-2
E5185	51R	24237.2	1466.87	1277395.0	10.00	7.51E+5	1.57E-2
51R	E5188	2081.8	365.34	317908.9	4.00	1.61E+5	2.01E-2
51R	56A	20924.3	629.57	547866.6	14.00	4.63E+5	1.53E-2
56A	E5604	2772.8	21.06	18341.3	4.00	2.15E+5	1.97E-2
56A	56B	254.7	132.48	115249.2	3.00	2.63E+4	2.64E-2
56B	E5609	179.6	17.57	15284.5	2.00	2.78E+4	2.71E-2
56A	56C	17429.7	135.28	117696.7	16.00	3.37E+5	1.55E-2
56C	56D	8862.1	1972.08	1716272.0	8.00	3.43E+5	1.70E-2
56D	56E	1090.6	561.67	488755.7	4.00	8.45E+4	2.14E-2

COMPUTED PIPE FLOWS AND PARAMETERS

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
56E	E5648		658.6	302.59	263586.8	2.00	1.02E+5	2.35E-2
56D	57A		6072.4	864.27	752470.0	6.00	3.14E+5	1.79E-2
57A	E5707		1845.5	11.57	10073.5	3.00	1.91E+5	2.09E-2
57A	E5703		3605.9	366.30	321182.2	3.00	3.72E+5	2.03E-2
56C	56F		7058.4	934.74	813167.4	16.00	1.37E+5	1.75E-2
56F	56G		-3994.7	216.46	188312.5	10.00	1.24E+5	1.85E-2
56G	56H		-4157.7	98.39	85597.4	10.00	1.29E+5	1.84E-2
56H	56I		-4313.1	216.47	188316.4	10.00	1.34E+5	1.83E-2
56I	E5365		367.6	19.50	16966.7	2.50	4.56E+4	2.46E-2
56I	56J		-4879.6	167.27	145519.5	10.00	1.51E+5	1.80E-2

56J	55A	9226.8	355.12	326181.9	4.00	7.15E+5	1.87E-2
55A	E5560	671.3	6.01	5303.3	1.50	1.39E+5	2.44E-2
56J	52B	-14810.7	885.19	770654.3	10.00	4.59E+5	1.61E-2
52B	E5307	361.2	196.75	171213.1	2.00	5.60E+4	2.47E-2
55A	E5590	109.1	217.66	190748.8	4.00	8.45E+3	3.34E-2
55A	54A	7519.2	1276.15	1140991.0	4.00	5.82E+5	1.88E-2
54A	54B	1080.4	734.64	648923.4	4.00	8.37E+4	2.15E-2
54B	E5425	67.6	11.15	9847.6	1.50	1.40E+4	3.14E-2
54B	E5427	569.2	141.45	125037.5	2.00	8.82E+4	2.37E-2
54A	54C	5316.1	234.48	208316.7	4.00	4.12E+5	1.90E-2
54C	E5452	809.6	15.67	13864.8	2.00	1.25E+5	2.31E-2
54C	54D	3843.0	1076.66	955521.5	4.00	2.98E+5	1.93E-2
54D	E5360	2156.1	41.82	37245.5	3.00	2.23E+5	2.07E-2
E5360	E5357	366.0	25.84	22901.5	2.00	5.67E+4	2.47E-2
54D	E5352	1054.8	145.62	128998.6	4.00	8.17E+4	2.15E-2
E5352	E5354	441.3	42.07	37260.6	3.00	4.56E+4	2.41E-2
56F	56K	7114.3	6721.50	5850477.0	8.00	2.75E+5	1.73E-2
56K	E5685	1853.1	33.35	29274.8	2.00	2.87E+5	2.23E-2
56K	E5695	1787.5	193.24	168189.1	6.00	9.23E+4	2.02E-2
E5695	E5697	291.6	196.26	170864.8	2.00	4.52E+4	2.54E-2
51KA	E5179	2912.8	254.79	222246.0	3.00	3.01E+5	2.04E-2
51KA	E5173	622.4	5.98	5211.7	1.50	1.29E+5	2.45E-2
E5126	E5125	43.5	15.78	13700.0	1.50	8.99E+3	3.44E-2
51HA	E5244	1033.1	6.17	5455.6	1.50	2.13E+5	2.40E-2
51HA	52A	20490.8	243.58	213336.2	8.00	7.93E+5	1.63E-2

SYSTEM MASS FLOWS

(1)	Steam to loads:	53330. lbm/hr
(2)	Steam condensed in pipes:	29127. lbm/hr
(3)	Steam condensed in vaults:	0. lbm/hr
(4)	Steam lost to trap leakage:	0. lbm/hr
(5)	Total steam plant output:	82457. lbm/hr
(6)	Pipe and vault condensate returned:	11651. lbm/hr
(7)	Load condensate returned:	21332. lbm/hr
(8)	Total condensate returned:	32983. lbm/hr

SYSTEM HEAT LOSSES AND DISTRIBUTION EFFICIENCY
(M = Million)

(1)	Total pipe conduction heat losses:	25.483 MBtus/hr	73.17 %
(2)	Total pipe condensate heat losses:	5.598 MBtus/hr	16.07 %
(3)	Total load condensate heat losses:	3.745 MBtus/hr	10.75 %
(4)	Total vault conduction heat losses:	.000 MBtus/hr	.00 %
(5)	Total vault condensate heat losses:	.000 MBtus/hr	.00 %
(6)	Total trap heat losses:	.000 MBtus/hr	.00 %
(7)	Total heat losses:	34.826 MBtus/hr	100.00 %
(8)	Total heat to loads:	57.315 MBtus/hr	
(9)	Total heat input to supply:	98.357 MBtus/hr	
(10)	Total heat returned to plant:	2.497 MBtus/hr	
(11)	Net heat input from plant:	95.860 MBtus/hr	

DISTRIBUTION EFFICIENCY: 63.7% [1.0-(7)/(11)]

10/12/93 09:46
E3312

SOLUTION COMPLETED IN 9 ITERATIONS
SOME NODES MAY NOT BE BALANCED

*** PROBLEM SUMMARY ***

99	NODES IN THE SYSTEM
103	PIPES IN THE SYSTEM
0	VALVES OR REGULATORS
30	PERCENT TRAP LEAKAGE
0	VAULTS IN THE SYSTEM
0	UNKNOWN PARAMETERS
98	UNKNOWN PRESSURES
1	UNKNOWN FLOWS

COMPUTED NODE DATA

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESI (lbm
E3312	125.00	67846.4?	-1424.4	.0	92508.5	352.9	
33A	124.74?	.0	-196.0	.0	12720.6	352.7	-
E3320	124.74?	-298.9	-2.9	6997.2	191.0	352.7	-
E3331	124.61?	-1896.9	-35.1	44405.9	2280.3	352.6	-
35A	123.80?	.0	-147.0	.0	9524.8	352.2	
E3516	123.36?	-4633.1	-88.6	108459.5	5739.1	351.9	
E3510	122.52?	-1684.9	-73.2	39443.0	4734.9	351.5	-
35B	122.17?	.0	-31.6	.0	2044.6	351.3	-
E3500	122.14?	-289.0	-3.8	6765.4	245.8	351.3	
E3514	121.16?	-283.0	-17.5	6624.9	1131.5	350.7	
35C	120.34?	.0	-16.1	.0	1037.4	350.2	-
T3517	120.34?	-83.2	-1.0	1947.7	66.6	350.2	
35D	120.05?	.0	-12.4	.0	795.3	350.1	
T3518	120.05?	-84.5	-1.0	1978.1	66.5	350.1	-
35E	119.81?	.0	-13.6	.0	876.4	349.9	
T3519	119.80?	-83.2	-1.0	1947.7	66.5	349.9	-
35F	119.66?	.0	-11.1	.0	714.5	349.8	-
T3521	119.65?	-88.4	-1.0	2069.4	66.4	349.8	
35G	119.61?	.0	-17.4	.0	1119.9	349.8	
T3523	119.61?	-89.7	-1.0	2099.9	66.4	349.8	-
E3525	119.56?	-181.4	-12.6	4246.5	810.3	349.8	-
35H	122.43?	.0	-48.2	.0	3113.9	351.4	-
35I	122.41?	.0	-35.2	.0	2275.9	351.4	
E3550	122.40?	-388.5	-10.5	9094.7	676.6	351.4	
35J	121.97?	.0	-37.6	.0	2426.3	351.2	
E3546	121.18?	-192.1	-11.1	4497.0	713.7	350.7	-
E3544	121.81?	-88.3	-12.5	2067.1	804.3	351.1	
E3542	121.76?	-85.6	-6.2	2003.9	402.2	351.0	-
33B	124.74?	.0	-168.3	.0	10927.8	352.7	-
T3360	124.52?	-230.1	-.7	5386.6	44.6	352.6	-
33C	124.16?	.0	-271.3	.0	17595.6	352.4	
T3370	123.13?	-160.9	-5.5	3766.6	355.9	351.8	-
36A	123.46?	.0	-295.6	.0	19142.8	352.0	
E3615	120.30?	-692.7	-16.4	16215.9	1058.8	350.2	-
E3622	123.39?	.0	-6.2	.0	401.5	352.0	-
36B	122.95?	.0	-494.4	.0	31991.3	351.7	
35K	121.42?	.0	-161.2	.0	10400.1	350.9	
35L	121.41?	.0	-44.5	.0	2868.8	350.8	-
E3563	121.41?	-85.1	-7.3	1992.2	469.6	350.8	

E3567	121.36?	-29.1	-2.1	681.2	132.7	350.8	-
35M	121.40?	.0	-42.3	.0	2727.0	350.8	-
E3560	121.39?	-160.9	-16.7	3766.6	1074.9	350.8	
37A	122.90?	.0	-764.4	.0	49459.5	351.7	-
E3726	122.82?	-490.3	-88.6	11477.8	5731.8	351.6	-
E3728	122.75?	-193.5	-17.8	4529.8	1150.0	351.6	-
E3724	122.80?	-324.6	-22.7	7598.8	1468.6	351.6	-
E3580	122.53?	-618.3	-108.2	14474.2	6997.4	351.5	-
E3835	122.90?	.0	-345.1	.0	22329.1	351.7	
E3081	122.51?	-4150.7	-1035.9	97166.7	66976.5	351.5	-
33D	120.08?	.0	-118.7	.0	7636.8	350.1	-
E3348	120.06?	-94.3	-2.1	2207.5	133.1	350.1	
33E	118.99?	.0	-102.0	.0	6550.5	349.5	-
E3334	118.99?	-33.6	-26.0	786.6	1667.2	349.5	
33F	116.15?	.0	-182.3	.0	11646.0	347.8	-

(2)

COMPUTED NODE DATA

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESI (lbm
E3329	112.29?	-41.5	-13.7	971.5	866.3	345.5	
E3328	111.51?	-38.8	-17.0	908.3	1073.7	345.1	
E3326	111.08?	-42.8	-21.4	1001.9	1352.4	344.8	
E3325	111.04?	-33.9	-12.1	793.6	767.2	344.8	-
32A	109.90?	.0	-133.7	.0	8436.0	344.1	
32B	109.70?	.0	-125.9	.0	7943.4	344.0	-
T3265	109.88?	-414.1	-8.5	9694.0	533.5	344.1	-
32C	108.53?	.0	-57.4	.0	3612.7	343.3	-
E3266	108.12?	-402.8	-15.1	9429.4	948.8	343.0	-
32D	108.23?	.0	-35.0	.0	2204.2	343.1	-
E3226	108.00?	-1405.2	-24.8	32895.3	1560.7	342.9	-
E3224	107.02?	-446.2	-55.9	10445.4	3508.0	342.3	
E3220	105.79?	-3122.7	-151.7	73101.5	9493.6	341.6	-
E3222	105.80?	-2454.4	-147.2	57456.8	9208.9	341.6	-873
32E	105.81?	.0	-134.3	.0	8401.7	341.6	874
32F	106.46?	.0	-90.2	.0	5653.7	342.0	
32G	107.42?	.0	-191.6	.0	12031.4	342.6	
E3244	107.18?	-590.8	-73.9	13830.5	4636.2	342.4	-
32L	105.74?	.0	-60.5	.0	3786.3	341.5	
32H	104.50?	.0	-58.6	.0	3655.7	340.8	-
E3228	104.49?	-353.9	-1.2	8284.7	75.6	340.7	-
32I	104.40?	.0	-22.9	.0	1425.9	340.7	
E3230	104.38?	-436.6	-1.2	10220.7	75.6	340.7	-
32J	104.31?	.0	-18.7	.0	1166.4	340.6	
E3232	104.29?	-358.0	-1.2	8380.7	75.5	340.6	-
32K	104.30?	.0	-4.5	.0	283.4	340.6	-
E3234	104.28?	-425.9	-1.2	9970.2	75.5	340.6	
E3242	105.64?	-103.5	-14.9	2422.9	935.1	341.5	-

31A	104.32?	.0	-350.4	.0	21854.5	340.6
E3100	104.05?	-5706.1	-76.6	133578.2	4778.4	340.5
31B	104.08?	.0	-474.1	.0	29561.9	340.5
T3148	104.08?	-293.6	-24.7	6873.1	1538.3	340.5
E3160	103.91?	-1500.3	-263.0	35121.6	16389.9	340.4
T3161	103.58?	-427.1	-25.4	9998.3	1580.7	340.2
T3165	103.55?	-95.1	-14.5	2226.3	903.6	340.2
E3240	104.96?	-211.8	-12.1	4958.2	758.2	341.0
31AA	105.03?	.0	-164.9	.0	10301.0	341.1
35GA	122.67?	.0	-63.8	.0	4126.7	351.6
E3540	122.66?	-143.3	-1.0	3354.6	67.3	351.6
E3552	122.33?	-192.9	-17.8	4515.7	1148.0	351.4
35KA	120.89?	.0	-170.3	.0	10980.3	350.6
E3570	120.89?	-1007.2	-14.3	23578.3	922.5	350.6
E3549	119.77?	-10457.4	-113.5	244804.8	7300.5	349.9
E3566	120.99?	-137.2	-2.7	3211.8	176.4	350.6
E3330	124.98?	-5535.6	-36.7	129586.8	2383.4	352.9

(3)

COMPUTED PIPE FLOWS AND PARAMETERS

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	
E3312	33A		2552.7	315.75	274213.4	5.00	1.58E+5	1
33A	E3320		342.8	5.88	5108.2	2.50	4.25E+4	2
33A	E3331		1972.9	70.27	61044.7	4.00	1.53E+5	2
E3312	35A		10366.8	94.60	83587.1	5.00	6.42E+5	1
35A	E3516		8380.5	52.88	46367.9	5.00	5.19E+5	1
35A	E3510		1798.4	146.47	127583.5	3.00	1.86E+5	2
E3516	35B		1880.5	40.68	35628.6	2.50	2.33E+5	2
35B	E3500		333.1	7.61	6615.5	2.00	5.16E+4	2
35B	E3514		1475.5	15.00	13218.9	2.00	2.29E+5	2
E3514	35C		1134.9	20.09	17595.4	2.00	1.76E+5	2
35C	T3517		124.0	2.07	1800.9	1.50	2.56E+4	2
35C	35D		955.0	10.06	8788.7	2.00	1.48E+5	2
35D	T3518		125.2	2.07	1800.0	1.50	2.59E+4	2
35D	35E		777.7	12.59	10980.3	2.00	1.20E+5	2
35E	T3519		123.8	2.07	1799.1	1.50	2.56E+4	2
35E	35F		600.5	12.59	10976.3	2.00	9.30E+4	2
35F	T3521		129.1	2.07	1798.6	1.50	2.67E+4	2

35F	35G		420.9	7.56	6584.6	2.00	6.52E+4	2.
35G	T3523		130.2	2.07	1798.5	1.50	2.69E+4	2.
35G	E3525		233.5	25.20	21946.5	2.00	3.62E+4	2.
E3516	35GA		1737.5	83.70	72885.4	3.00	1.79E+5	2.
35H	35I		766.0	13.96	12134.3	3.00	7.91E+4	2.
35I	E3550		439.4	20.94	18200.9	3.00	4.54E+4	2.
35H	35J		594.0	40.54	35285.7	2.00	9.20E+4	2.
35J	E3546		243.2	22.13	19274.5	1.25	6.03E+4	2.
35J	E3544		273.0	12.46	10836.8	1.50	5.64E+4	2.
E3544	E3542		132.0	12.46	10834.6	1.50	2.73E+4	2.
E3312	33B		18735.3	102.09	89198.1	8.00	7.25E+5	1.
33B	T3360		271.8	1.37	1199.9	1.00	8.42E+4	2.
33B	33C		18254.1	233.20	203726.7	8.00	7.07E+5	1.
33C	T3370		207.0	11.00	9581.8	1.00	6.41E+4	2.
33C	36A		17734.7	298.46	260722.9	8.00	6.87E+5	1.
36A	E3615		748.9	32.89	28897.8	1.50	1.55E+5	2.
36A	E3622		46.9	12.40	10775.2	1.00	1.45E+4	3.
36A	36B		16602.7	247.39	215970.3	8.00	6.43E+5	1.
36B	35K		12851.5	215.49	189715.0	6.00	6.64E+5	1.
35K	35L		767.7	21.80	18962.8	4.00	5.95E+4	2.
35L	E3563		203.8	10.44	9083.7	3.00	2.10E+4	2.
E3563	E3567		71.2	4.11	3578.3	1.00	2.21E+4	3.
35L	35M		479.7	56.68	49302.6	4.00	3.71E+4	2.
35M	E3560		397.7	27.85	24222.6	3.00	4.11E+4	2.
36B	37A		3215.9	525.95	457114.8	8.00	1.25E+5	1.
37A	E3726		1258.8	96.24	83659.8	4.00	9.75E+4	2.
E3726	E3728		251.7	35.56	30908.0	2.00	3.90E+4	2.
E3726	E3724		387.7	45.41	39464.9	3.00	4.00E+4	2.
37A	E3580		766.8	216.45	188184.5	3.00	7.92E+4	2.
37A	E3835		385.8	690.24	599887.7	6.00	1.99E+4	2.
E3312	E3081		5226.4	2071.85	1802496.0	6.00	2.70E+5	1.
E3312	E3330		5614.6	73.40	63727.1	8.00	2.17E+5	1.
E3312	33D		23883.8	191.04	179852.5	6.00	1.23E+6	1.
33D	E3348		136.1	4.14	3600.0	1.50	2.81E+4	2.
33D	33E		23589.4	42.13	39743.5	6.00	1.22E+6	1.
33E	E3334		99.2	51.91	45213.4	3.00	1.02E+4	3.
33E	33F		23349.1	109.93	103939.5	6.00	1.21E+6	1.

(4)

COMPUTED PIPE FLOWS AND PARAMETERS

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	F
33F	E3329		370.0	11.91	10589.4	1.00	1.15E+5	2.
E3329	E3328		277.4	15.42	13513.7	1.25	6.87E+4	2.
E3328	E3326		184.4	18.50	16196.7	1.25	4.57E+4	2.
E3326	E3325		83.1	24.26	21225.6	1.50	1.72E+4	3.
33F	32A		22758.2	242.76	230588.2	6.00	1.18E+6	1.
32A	32B		22128.1	7.71	7311.4	6.00	1.14E+6	1.

32A	T3265	459.3	16.91	14804.9	3.00	4.74E+4 2.
32B	32C	5107.1	83.62	74057.4	4.00	3.96E+5 1.
32C	E3266	312.9	6.10	5366.4	1.25	7.76E+4 2.
32C	32D	4700.4	25.10	22183.6	4.00	3.64E+5 1.
32D	E3266	141.1	24.08	21101.3	1.50	2.91E+4 2.
32D	E3226	4487.9	20.92	18476.2	4.00	3.48E+5 1.
E3226	E3224	1510.8	16.74	14881.6	2.00	2.34E+5 2.
E3224	E3220	2483.6	83.11	73346.5	3.00	2.56E+5 2.
E3220	E3222	-826.0	220.34	193364.0	6.00	4.26E+4 2.
E3222	32E	910.5	16.53	14502.4	6.00	4.70E+4 2.
32F	E3222	3987.3	12.99	11752.4	3.00	4.12E+5 2.
32F	32E	11816.6	92.51	82237.0	6.00	6.10E+5 1.
32B	32G	16858.4	160.53	145859.6	6.00	8.70E+5 1.
32G	32F	15930.1	74.97	67839.3	6.00	8.22E+5 1.
32G	E3244	700.5	147.76	129591.7	3.00	7.23E+4 2.
32E	32L	1727.6	6.67	5871.8	3.00	1.78E+5 2.
32L	32H	1965.1	99.77	87955.7	3.00	2.03E+5 2.
32H	E3228	390.3	2.42	2129.4	2.00	6.05E+4 2.
32H	32I	1481.1	14.97	13174.5	3.00	1.53E+5 2.
32I	E3230	472.8	2.42	2128.9	2.00	7.32E+4 2.
32I	32J	950.0	28.31	24880.0	3.00	9.81E+4 2.
32J	E3232	394.3	2.42	2128.5	2.00	6.11E+4 2.
32J	32K	501.7	6.66	5853.5	3.00	5.18E+4 2.
32K	E3234	462.3	2.42	2128.5	2.00	7.16E+4 2.
E3222	E3242	153.9	29.90	26242.3	1.50	3.18E+4 2.
32L	E3222	-333.7	14.59	12811.1	2.00	5.17E+4 2.
32E	31AA	9955.3	152.83	135245.7	6.00	5.14E+5 1.
31A	E3100	5817.5	153.29	134891.4	6.00	3.00E+5 1.
31A	31B	3292.2	394.74	346877.6	6.00	1.70E+5 1.
31B	T3148	353.3	49.35	43348.7	6.00	1.82E+4 2.
31B	E3160	2429.7	504.21	443039.5	6.00	1.25E+5 1.
E3160	T3161	631.9	21.74	19134.1	2.00	9.79E+4 2.
E3226	E3224	1510.8	11.99	10714.7	2.00	2.34E+5 2.
T3161	T3165	144.5	29.02	25502.3	2.00	2.24E+4 2.
35I	E3552	251.0	35.52	30884.5	2.00	3.89E+4 2.
35K	35KA	11882.0	85.07	74745.1	6.00	6.13E+5 1.
35KA	E3570	1060.6	28.62	24902.9	6.00	5.48E+4 2.
35KA	E3549	10610.2	226.98	199015.2	6.00	5.48E+5 1.
E3560	E3566	179.9	5.47	4769.3	1.00	5.57E+4 2.
31AA	31A	9495.8	152.67	135033.1	6.00	4.90E+5 1.
31AA	E3240	259.2	24.28	21316.9	2.00	4.01E+4 2.
35GA	35H	1448.5	41.84	36411.8	3.00	1.50E+5 2.
35GA	E3540	184.8	2.08	1808.7	1.50	3.82E+4 2.

COMPUTED TRAP LOSSES

30 percent trap leakage rate

Trap Steam Losses	Trap Heat Losses
3816.6 lbs/hr	4548662.0 Btus/hr

(6)

SYSTEM MASS FLOWS

(1)	Steam to loads:	54094.	lbm/hr
(2)	Steam condensed in pipes:	9936.	lbm/hr
(3)	Steam condensed in vaults:	0.	lbm/hr
(4)	Steam lost to trap leakage:	3817.	lbm/hr
(5)	Total steam plant output:	67846.	lbm/hr
(6)	Pipe and vault condensate returned:	7949.	lbm/hr
(7)	Load condensate returned:	43275.	lbm/hr
(8)	Total condensate returned:	51224.	lbm/hr

SYSTEM HEAT LOSSES AND DISTRIBUTION EFFICIENCY
(M = Million)

(1)	Total pipe conduction heat losses:	8.733	MBtus/hr	57.51 %
(2)	Total pipe condensate heat losses:	.637	MBtus/hr	4.19 %
(3)	Total load condensate heat losses:	1.266	MBtus/hr	8.34 %
(4)	Total vault conduction heat losses:	.000	MBtus/hr	.00 %
(5)	Total vault condensate heat losses:	.000	MBtus/hr	.00 %
(6)	Total trap heat losses:	4.549	MBtus/hr	29.96 %
(7)	Total heat losses:	15.185	MBtus/hr	100.00 %
(8)	Total heat to loads:	58.135	MBtus/hr	
(9)	Total heat input to supply:	80.929	MBtus/hr	
(10)	Total heat returned to plant:	5.065	MBtus/hr	
(11)	Net heat input from plant:	75.864	MBtus/hr	

DISTRIBUTION EFFICIENCY: 80.0% [1.0-(7)/(11)]

10/12/93 09:48
E4160

SOLUTION COMPLETED IN 8 ITERATIONS

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*** PROBLEM SUMMARY ***
45 NODES IN THE SYSTEM
44 PIPES IN THE SYSTEM
 0 VALVES OR REGULATORS
 0 FAULTY TRAPS
 0 VAULTS IN THE SYSTEM
 0 UNKNOWN PARAMETERS
44 UNKNOWN PRESSURES
 1 UNKNOWN FLOWS
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COMPUTED NODE DATA

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESI (lbm
E4160	60.00	14656.1?	-126.3	.0	7001.6	307.3	-
E4162	59.99?	-68.8	-6.1	1610.6	339.1	307.3	
E4810	59.02?	-414.4	-39.0	9701.0	2154.3	306.4	
44A	59.32?	.0	-219.2	.0	12127.3	306.7	1
44B	59.17?	.0	-33.7	.0	1865.6	306.6	-
E4465	59.01?	-914.6	-4.7	21410.5	258.8	306.4	-
E4470	58.94?	-782.5	-9.4	18318.1	518.1	306.4	-
44C	59.25?	.0	-105.5	.0	5835.8	306.7	-
E4430	59.02?	-782.5	-9.4	18318.1	518.5	306.4	-
44D	59.23?	.0	-89.5	.0	4948.3	306.6	-
E4140	59.21?	-247.6	-57.6	5796.2	3186.9	306.6	
44E	59.22?	.0	-30.8	.0	1703.1	306.6	
E4405	59.22?	.0	-4.7	.0	260.2	306.6	
E4410	59.17?	-342.6	-9.4	8020.2	520.2	306.6	-
44F	59.15?	.0	-142.6	.0	7882.3	306.6	
E4620	58.88?	-1058.9	-75.7	24788.5	4182.3	306.3	-
44G	58.49?	.0	-62.2	.0	3429.0	305.9	-
44H	58.36?	.0	-31.7	.0	1745.4	305.8	-
E4480	58.29?	-741.5	-3.5	17358.3	193.3	305.8	
E4475	58.22?	-698.4	-7.0	16349.3	386.7	305.7	
44I	58.31?	.0	-53.9	.0	2971.3	305.8	
E4455	58.08?	-781.8	-9.3	18301.7	514.6	305.6	-
E4460	58.19?	-781.8	-4.7	18301.7	257.5	305.7	-
44J	57.03?	.0	-58.7	.0	3221.1	304.6	
44K	56.40?	.0	-30.8	.0	1686.5	304.0	-
44L	55.89?	.0	-55.7	.0	3042.4	303.5	
E4420	56.29?	-414.0	-13.9	9691.6	762.5	303.9	-
44M	55.86?	.0	-14.4	.0	786.9	303.5	
E4415	55.76?	-509.5	-9.3	11927.2	506.0	303.4	-
42A	46.97?	.0	-76.6	.0	4047.3	294.5	
42B	46.64?	.0	-34.2	.0	1803.7	294.2	
E4227	46.62?	-647.4	-2.5	15155.4	129.4	294.2	-
42C	46.25?	.0	-56.3	.0	2963.2	293.7	-
E4228	46.24?	-229.1	-2.5	5363.2	129.0	293.7	
E4229	46.00?	-647.4	-29.4	15155.4	1544.4	293.5	-
42D	45.70?	.0	-48.3	.0	2538.4	293.2	-
E4224	45.69?	-229.1	-4.9	5363.2	256.7	293.2	
42E	44.96?	.0	-53.3	.0	2793.1	292.4	
E4223	44.86?	-454.8	-21.9	10646.7	1146.1	292.3	-

42F	44.76?	.0	-46.2	.0	2415.4	292.1	
E4222	44.72?	-647.3	-4.9	15153.1	254.2	292.1	-
E4221	44.72?	-229.1	-29.2	5363.2	1526.2	292.1	-
E4435	56.89?	-630.3	-8.1	14755.1	446.5	304.4	-
E4440	56.96?	-598.8	-4.7	14017.7	255.3	304.5	-
44IA	58.03?	.0	-62.6	.0	3449.2	305.5	-

(2)

COMPUTED PIPE FLOWS AND PARAMETERS

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	F
E4160	E4162		74.9	12.23	11065.5	2.00	1.16E+4	3.
E4160	E4810		453.5	77.96	70697.3	2.00	7.02E+4	2.
E4160	44A		14002.3	162.34	149334.3	8.00	5.42E+5	1.
44A	44B		1744.8	39.36	35699.6	4.00	1.35E+5	2.
44B	E4465		919.3	9.37	8516.0	2.50	1.14E+5	2.
44B	E4470		791.8	18.76	17029.6	2.50	9.81E+4	2.
44A	44C		1679.4	161.93	146619.3	6.00	8.67E+4	2.
44C	E4430		791.8	18.76	17034.9	2.50	9.81E+4	2.
44C	44D		782.1	30.33	27460.7	4.00	6.06E+4	2.
44D	E4140		305.2	115.25	104342.4	4.00	2.36E+4	2.
44D	44E		387.7	33.36	30204.9	4.00	3.00E+4	2.
44E	E4405		4.7	9.41	8519.9	2.50	5.84E+2	7.
44E	E4410		352.0	18.81	17038.2	2.50	4.36E+4	2.
44A	44F		10357.5	74.79	68163.3	8.00	4.01E+5	1.
44F	E4620		1134.5	151.42	137193.9	4.00	8.79E+4	2.
44F	44G		9080.4	58.91	54889.7	6.00	4.69E+5	1.
44G	44H		1482.0	42.26	38332.3	4.00	1.15E+5	2.
44H	E4480		745.0	7.01	6369.3	2.50	9.23E+4	2.
44H	E4475		705.4	14.03	12737.3	2.50	8.74E+4	2.
44G	44I		7536.6	23.14	21313.5	6.00	3.89E+5	1.
44I	E4455		791.1	18.68	16976.7	2.50	9.80E+4	2.
44I	E4460		786.4	9.35	8490.2	2.50	9.74E+4	2.
44I	44IA		5904.6	56.62	51718.7	6.00	3.05E+5	1.
44J	44K		4541.6	23.16	21766.9	4.00	3.52E+5	1.
44K	44L		4082.9	10.57	10149.8	3.50	3.61E+5	1.
44K	E4420		427.9	27.86	25292.0	2.50	5.30E+4	2.
44L	44M		533.1	10.27	9328.5	3.00	5.51E+4	2.
44M	E4415		518.7	18.52	16827.7	2.50	6.43E+4	2.

44L	42A	3494.1	90.48	91719.1	3.00	3.61E+5 2.
42A	42B	1648.6	14.56	13488.2	3.00	1.70E+5 2.
42B	E4227	649.8	4.91	4492.6	3.00	6.71E+4 2.
42B	42C	964..5	48.93	44889.3	3.00	9.96E+4 2.
42C	E4228	231.7	4.90	4485.0	3.00	2.39E+4 2.
42C	E4229	676.7	58.72	53791.4	3.00	6.99E+4 2.
42A	42D	1768.8	48.24	44868.4	3.00	1.83E+5 2.
42D	E4224	234.0	9.78	8948.3	3.00	2.42E+4 2.
42D	42E	1486.5	38.63	35734.8	3.00	1.54E+5 2.
42E	E4223	476.6	43.79	40126.1	3.00	4.92E+4 2.
42E	42F	956.5	24.26	22287.1	3.00	9.88E+4 2.
42F	E4222	652.1	9.72	8910.0	3.00	6.73E+4 2.
42F	E4221	258.2	58.35	53459.9	3.00	2.67E+4 2.
44J	E4435	638.4	16.28	14787.5	2.50	7.91E+4 2.
44J	E4440	603.4	9.31	8451.0	2.50	7.48E+4 2.
44IA	44J	5842.1	68.63	63764.2	5.00	3.62E+5 1.

(3)

SYSTEM MASS FLOWS

(1)	Steam to loads:	12852. lbm/hr
(2)	Steam condensed in pipes:	1804. lbm/hr
(3)	Steam condensed in vaults:	0. lbm/hr
(4)	Steam lost to trap leakage:	0. lbm/hr
(5)	Total steam plant output:	14656. lbm/hr
(6)	Pipe and vault condensate returned:	1443. lbm/hr
(7)	Load condensate returned:	10282. lbm/hr
(8)	Total condensate returned:	11725. lbm/hr

SYSTEM HEAT LOSSES AND DISTRIBUTION EFFICIENCY
(M = Million)

(1)	Total pipe conduction heat losses:	1.657 MBtus/hr	80.58 %
(2)	Total pipe condensate heat losses:	.099 MBtus/hr	4.79 %
(3)	Total load condensate heat losses:	.301 MBtus/hr	14.63 %
(4)	Total vault conduction heat losses:	.000 MBtus/hr	.00 %
(5)	Total vault condensate heat losses:	.000 MBtus/hr	.00 %
(6)	Total trap heat losses:	.000 MBtus/hr	.00 %
(7)	Total heat losses:	2.057 MBtus/hr	100.00 %
(8)	Total heat to loads:	13.670 MBtus/hr	
(9)	Total heat input to supply:	17.324 MBtus/hr	
(10)	Total heat returned to plant:	1.203 MBtus/hr	
(11)	Net heat input from plant:	16.120 MBtus/hr	

DISTRIBUTION EFFICIENCY: 87.2% [1.0-(7)/(11)]

(4)

SOLUTION COMPLETED IN 7 ITERATIONS
SOME NODES MAY NOT BE BALANCED

*** PROBLEM SUMMARY ***

7 NODES IN THE SYSTEM
6 PIPES IN THE SYSTEM
0 VALVES OR REGULATORS
0 FAULTY TRAPS
0 VAULTS IN THE SYSTEM
0 UNKNOWN PARAMETERS
6 UNKNOWN PRESSURES
1 UNKNOWN FLOWS

COMPUTED NODE DATA

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESI (lbm
E4225	125.00	4806.8?	-69.1	.0	4485.1	352.9	17
E4230	124.59?	-1193.5	-44.9	27939.5	2912.5	352.6	-5
42M	124.68?	.0	-173.6	.0	11265.2	352.7	-16
E4210	124.42?	-1675.1	-59.9	39213.6	3886.9	352.5	2
42N	124.41?	.0	-127.1	.0	8243.5	352.5	1
E4220	124.37?	-232.6	-12.0	5445.1	777.4	352.5	
E4215	124.18?	-1193.5	-25.6	27939.5	1661.2	352.4	1

(2)

COMPUTED PIPE FLOWS AND PARAMETERS

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	F
E4225	E4230		1232.5	89.75	77989.1	3.00	1.27E+5	2.
E4225	42M		3488.2	48.36	42116.1	4.00	2.70E+5	1.
42M	E4210		1737.6	119.82	104098.9	4.00	1.35E+5	2.
42M	42N		1593.4	178.92	155421.4	4.00	1.23E+5	2.
42N	E4220		244.7	23.97	20813.8	2.00	3.79E+4	2.
42N	E4215		1220.6	51.23	44524.2	3.00	1.26E+5	2.

(3)

SYSTEM MASS FLOWS

(1)	Steam to loads:	4295. lbm/hr
(2)	Steam condensed in pipes:	512. lbm/hr
(3)	Steam condensed in vaults:	0. lbm/hr
(4)	Steam lost to trap leakage:	0. lbm/hr
(5)	Total steam plant output:	4807. lbm/hr
(6)	Pipe and vault condensate returned:	410. lbm/hr
(7)	Load condensate returned:	3436. lbm/hr
(8)	Total condensate returned:	3845. lbm/hr

SYSTEM HEAT LOSSES AND DISTRIBUTION EFFICIENCY
(M = Million)

(1)	Total pipe conduction heat losses:	.445 MBtus/hr	76.89 %
(2)	Total pipe condensate heat losses:	.033 MBtus/hr	5.74 %
(3)	Total load condensate heat losses:	.101 MBtus/hr	17.37 %
(4)	Total vault conduction heat losses:	.000 MBtus/hr	.00 %
(5)	Total vault condensate heat losses:	.000 MBtus/hr	.00 %
(6)	Total trap heat losses:	.000 MBtus/hr	.00 %
(7)	Total heat losses:	.579 MBtus/hr	100.00 %
(8)	Total heat to loads:	4.620 MBtus/hr	
(9)	Total heat input to supply:	5.734 MBtus/hr	
(10)	Total heat returned to plant:	.402 MBtus/hr	
(11)	Net heat input from plant:	5.331 MBtus/hr	

DISTRIBUTION EFFICIENCY: 89.1% [1.0-(7)/(11)]

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APG - Alternative 3
Consolidate E5126,E4160,E4225 and close Steam Loop

SOLUTION COMPLETED IN 9 ITERATIONS
SOME NODES MAY NOT BE BALANCED

*** PROBLEM SUMMARY ***
241 NODES IN THE SYSTEM
242 PIPES IN THE SYSTEM
4 VALVES OR REGULATORS
15 PERCENT TRAP LEAKAGE
0 VAULTS IN THE SYSTEM
4 UNKNOWN PARAMETERS
236 UNKNOWN PRESSURES
1 UNKNOWN FLOWS

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESIDUAL (lbm/hr)
P5126	350.00	140676.7?	-1068.5	.0	265524.3	435.6	1.62
E5126	150.00	.0	-766.4	.0	155641.9	365.9	-19.42
51A	149.94?	.0	-342.5	.0	69550.2	365.8	8.99
51B	149.67?	.0	-99.3	.0	20156.1	365.7	-.55
E5116	149.59?	-19.8	-8.3	1390.5	1684.7	365.7	-.02
E5100	149.52?	-2230.3	-35.5	156632.1	7205.5	365.6	-.28
51C	149.82?	.0	-149.8	.0	30413.6	365.8	-1.25
E5106	149.47?	-585.1	-23.2	41091.1	4705.3	365.6	-.05
51D	149.81?	.0	-99.7	.0	20240.8	365.8	.22
E5103	149.41?	-394.1	-46.4	27677.3	9412.0	365.6	-.07
51E	147.79?	.0	-86.0	.0	17398.5	364.8	.11
E5137	147.33?	-275.7	-1.6	19362.2	332.9	364.6	-.01
E5135	146.92?	-209.2	-4.9	14691.9	999.9	364.3	-.02
51F	137.06?	.0	-23.0	.0	4575.8	359.3	.01
E5232	135.00?	-599.2	-1.5	42081.3	305.4	358.3	-.01
51G	130.38?	.0	-44.0	.0	8651.8	355.8	.01
E5234	128.63?	-539.0	-1.5	37853.5	300.7	354.9	-.01
E5236	124.93?	-770.1	-30.2	54083.5	5879.4	352.8	-.04
51H	148.99?	.0	-278.5	.0	56468.2	365.4	1.22
51I	147.16?	.0	-50.8	.0	10267.4	364.5	.01
E5140	146.83?	-1030.0	-1.3	72336.0	263.3	364.3	-.01
E5141	146.98?	-142.8	-21.1	10028.7	4274.3	364.4	-.04
52A	148.47?	.0	-237.7	.0	48153.8	365.1	.46
E5246	148.40?	-1144.8	-11.4	80398.3	2314.6	365.1	-.10
52B	148.10?	.0	-783.3	.0	158617.8	364.9	1.11
52C	148.07?	.0	-300.4	.0	60829.1	364.9	-.20
E5422	147.88?	-265.0	-42.7	18610.7	8642.3	364.8	-.08
E5265	147.80?	-2170.3	-65.2	152418.3	13206.1	364.8	-.11
E5266	147.79?	-13.1	-3.3	920.0	669.7	364.8	-.06
51J	149.96?	.0	-179.8	.0	36511.4	365.8	8.53
E5165	149.80?	-985.7	-135.5	69224.9	27509.8	365.8	-.69
51K	148.62?	.0	-34.7	.0	7038.6	365.2	-.28
E5175	148.62?	.0	-2.7	.0	537.3	365.2	.09
E5179	146.81?	-2785.4	-41.6	195616.3	8408.2	364.3	-.09
51L	148.79?	.0	-517.3	.0	104867.9	365.3	1.44
51M	130.43?	.0	-186.1	.0	36607.9	355.8	.18
E5101	130.30?	-2714.7	-3.7	190651.0	718.4	355.8	-.06
E5146	130.42?	-101.2	-10.3	7107.2	2027.8	355.8	-.09
51N	123.40?	.0	-100.0	.0	19437.3	352.0	.00
51O	122.88?	.0	-77.3	.0	15011.1	351.7	-.06
E5181	130.42?	-35.6	-.8	2500.2	157.2	355.8	-.02
E5180	118.23?	-331.4	-9.3	23273.9	1782.2	349.0	-.02
E5183	122.86?	-508.5	-10.8	35711.5	2105.8	351.7	.04
51P	120.86?	.0	-66.7	.0	12904.2	350.5	-.13
E5027	120.21?	-937.1	-2.5	65811.7	475.2	350.2	-.01
E5026	106.48?	-1711.1	-14.2	120169.1	2660.2	342.0	.00
E5185	148.19?	-11511.4	-384.3	808435.8	77837.3	365.0	-.44
51R	147.97?	.0	-474.7	.0	96106.2	364.9	2.39
E5188	147.79?	-1899.2	-57.5	133379.2	11641.9	364.8	-.27
56A	147.94?	.0	-336.5	.0	68128.8	364.9	5.51
E5604	147.88?	-2762.3	-8.8	193994.0	1790.4	364.8	-.15
56B	147.92?	.0	-64.1	.0	12972.8	364.8	-.46
E5609	147.90?	-170.9	-8.9	12002.2	1800.5	364.8	.13
56C	147.94?	.0	-645.6	.0	130708.7	364.9	-.24

(2)

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESIDUAL (lbm/hr)
56D	147.76?	.0	-464.4	.0	93982.7	364.8	-.56
56E	147.71?	.0	-152.4	.0	30845.6	364.7	-.24
E5648	146.83?	-507.3	-63.9	35627.2	12918.1	364.3	-.05
57A	147.46?	.0	-170.1	.0	34405.9	364.6	.33
E5707	147.43?	-1839.8	-1.9	129207.6	384.0	364.6	-.12
E5703	144.36?	-3422.8	-60.0	240380.3	12084.7	363.1	-.11
56F	147.94?	.0	-1331.4	.0	269542.3	364.9	-2.78
56G	147.94?	.0	-128.4	.0	25997.6	364.9	-4.73
56H	147.94?	.0	-128.4	.0	25997.8	364.9	3.99
56I	147.94?	.0	-165.1	.0	33422.7	364.9	-.38
E5365	147.92?	-357.9	-8.6	25135.0	1737.8	364.8	-.02
56J	147.94?	.0	-585.1	.0	118463.2	364.9	-2.41
55A	141.73?	.0	-401.9	.0	80575.4	361.7	-.07
E5560	141.43?	-668.3	-2.6	46934.1	521.7	361.6	-.04
E5307	147.50?	-262.9	-99.6	18463.2	20143.7	364.6	-.10
E5590	141.73?	.0	-35.0	.0	7015.3	361.7	.11
54A	135.68?	.0	-368.2	.0	73081.1	358.6	.14
54B	135.60?	.0	-154.8	.0	30723.4	358.6	.00
E5425	135.60?	-62.1	-2.6	4361.2	512.9	358.6	-.14
E5427	135.19?	-498.5	-31.2	35009.2	6193.3	358.4	-.08
54C	134.96?	.0	-220.3	.0	43676.4	358.2	.13
E5452	134.86?	-801.8	-3.5	56309.7	686.4	358.2	-.06
54D	132.92?	.0	-261.0	.0	51574.6	357.2	.01
E5360	132.50?	-1756.3	-32.2	123343.5	6358.9	356.9	.00
E5357	132.41?	-353.1	-13.8	24797.9	2724.1	356.9	-.08
E5352	132.85?	-519.7	-82.9	36498.1	16380.5	357.1	-.23
E5354	132.83?	-420.3	-18.5	29517.3	3648.7	357.1	.02
56K	147.63?	.0	-991.3	.0	200601.5	364.7	-1.70
E5685	146.72?	-1836.4	-7.0	128968.8	1417.1	364.3	-.02
E5695	147.61?	-1301.2	-170.8	91382.2	34569.9	364.7	.73
E5697	147.20?	-193.5	-99.5	13589.3	20121.4	364.5	-.10
E5125	149.99?	-35.6	-6.6	2500.2	1349.5	365.9	3.65
E5173	148.10?	-619.4	-1.3	43499.9	267.3	364.9	.01
51KA	148.22?	.0	-50.5	.0	10221.8	365.0	.00
51HA	148.82?	.0	-143.1	.0	29019.0	365.3	-.45
E5244	148.17?	-1030.0	-2.6	72336.0	529.3	365.0	.00
E3312	125.00	60000.0	-905.6	.0	58815.4	352.9	-4.86
33A	124.79?	.0	-40.8	.0	2646.0	352.7	.60
E3320	124.78?	-298.9	-.8	6997.2	53.8	352.7	.13
E3331	124.66?	-1896.9	-8.5	44405.9	552.4	352.7	-.07
35A	124.02?	.0	-33.0	.0	2139.8	352.3	.44
E3516	123.67?	-4633.1	-21.7	108459.5	1404.1	352.1	-.20
E3510	122.85?	-1684.9	-18.9	39443.0	1221.0	351.7	-.12
35B	122.89?	.0	-9.5	.0	617.6	351.7	-.03
E3500	122.87?	-289.0	-1.3	6765.4	83.9	351.7	.43
E3514	122.26?	-283.0	-6.0	6624.9	385.7	351.3	-.19
35C	121.79?	.0	-5.5	.0	352.3	351.1	-.02
T3517	121.78?	-83.2	-.3	1947.7	20.3	351.1	.01
35D	121.61?	.0	-4.2	.0	269.8	351.0	.01
T3518	121.61?	-84.5	-.3	1978.1	20.2	351.0	-.01
35E	121.47?	.0	-4.6	.0	297.8	350.9	.04
T3519	121.46?	-83.2	-.3	1947.7	20.2	350.9	-.06
35F	121.37?	.0	-3.8	.0	242.5	350.8	.26
T3521	121.37?	-88.4	-.3	2069.4	20.2	350.8	-.17

(3)

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESIDUAL (lbm/hr)
35G	121.34?	.0	-5.9	.0	381.6	350.8	-.11
T3523	121.34?	-89.7	-.3	2099.9	20.2	350.8	.00
E3525	121.30?	-181.4	-4.3	4246.5	278.0	350.8	.00
35H	123.08?	.0	-14.1	.0	914.9	351.8	-.35
35I	123.06?	.0	-10.6	.0	684.6	351.8	.34
E3550	123.05?	-388.5	-2.7	9094.7	175.6	351.8	-.10
35J	122.79?	.0	-11.5	.0	746.2	351.6	.07
E3546	122.17?	-192.1	-2.7	4497.0	177.1	351.3	-.03
E3544	122.68?	-88.3	-3.8	2067.1	243.9	351.6	.16
E3542	122.66?	-85.6	-1.9	2003.9	122.0	351.6	-.17
33B	124.81?	.0	-37.7	.0	2448.1	352.8	1.09
T3360	124.63?	-230.1	-.2	5386.6	12.6	352.7	.00
33C	124.40?	.0	-61.1	.0	3963.1	352.5	.32
T3370	123.59?	-160.9	-1.6	3766.6	101.5	352.1	-.02
36A	123.88?	.0	-67.8	.0	4396.7	352.2	-.29
E3615	120.98?	-692.7	-4.9	16215.9	315.0	350.6	-.03
E3622	123.86?	.0	-1.8	.0	114.9	352.2	-.01
36B	123.49?	.0	-108.6	.0	7031.2	352.0	.38
35K	122.11?	.0	-32.4	.0	2091.7	351.2	-.01
35L	122.11?	.0	-10.9	.0	703.6	351.2	.01
E3563	122.11?	-85.1	-1.9	1992.2	125.5	351.2	.41
E3567	122.08?	-29.1	-.6	681.2	38.0	351.2	-.03
35M	122.11?	.0	-10.5	.0	678.2	351.2	-.42
E3560	122.10?	-160.9	-4.4	3766.6	283.7	351.2	.06
37A	123.47?	.0	-170.1	.0	11017.4	352.0	-1.00
E3726	123.41?	-490.3	-23.6	11477.8	1530.3	352.0	.11
E3728	123.35?	-193.5	-6.1	4529.8	392.4	351.9	-.07
E3724	123.39?	-324.6	-5.9	7598.8	381.0	352.0	-.15
E3580	123.19?	-618.3	-28.0	14474.2	1815.4	351.9	-.14
E3835	123.47?	.0	-70.9	.0	4589.3	352.0	.80
E3081	123.23?	-4150.7	-212.3	97166.7	13741.5	351.9	.23
33D	121.36?	.0	-20.5	.0	1323.8	350.8	2.74
E3348	121.35?	-94.3	-.6	2207.5	40.4	350.8	.03
33E	120.56?	.0	-19.7	.0	1268.0	350.4	-3.39
E3334	120.56?	-33.6	-6.7	786.6	434.6	350.4	-.12
33F	118.43?	.0	-31.7	.0	2032.4	349.1	1.03
E3329	116.66?	-41.5	-3.6	971.5	233.4	348.1	.01
E3328	116.30?	-38.8	-4.3	908.3	271.9	347.9	.00
E3326	116.10?	-42.8	-6.0	1001.9	385.8	347.8	-.01
E3325	116.08?	-33.9	-3.7	793.6	237.4	347.8	-.03
32A	113.71?	.0	-23.5	.0	1493.3	346.4	-.08
32B	113.56?	.0	-26.1	.0	1661.6	346.3	.50
T3265	113.70?	-414.1	-2.2	9694.0	140.8	346.4	-.18
32C	112.65?	.0	-13.9	.0	880.1	345.7	.05
E3266	112.31?	-402.8	-4.4	9429.4	281.8	345.5	-.08
32D	112.41?	.0	-9.3	.0	587.0	345.6	-.07
E3226	112.22?	-1405.2	-6.6	32895.3	418.9	345.5	.00
E3224	111.48?	-446.2	-12.3	10445.4	777.6	345.0	.03
E3220	110.57?	-3122.7	-31.1	73101.5	1967.9	344.5	-.72
E3222	110.58?	-2454.4	-33.4	57456.8	2109.5	344.5	6.43
32E	110.58?	.0	-27.6	.0	1745.0	344.5	-5.60
32F	111.09?	.0	-18.2	.0	1153.9	344.8	.15
32G	111.83?	.0	-42.1	.0	2664.0	345.3	.05
E3244	111.64?	-590.8	-19.4	13830.5	1227.5	345.1	-.17

(4)

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESIDUAL (lbm/hr)
32L	110.54?	.0	-16.4	.0	1038.6	344.5	-.03
32H	109.59?	.0	-15.4	.0	972.8	343.9	-.11
E3228	109.57?	-353.9	-.4	8284.7	26.4	343.9	.03
32I	109.50?	.0	-6.1	.0	384.9	343.8	.06
E3230	109.48?	-436.6	-.4	10220.7	26.4	343.8	-.04
32J	109.43?	.0	-5.0	.0	316.3	343.8	-.21
E3232	109.42?	-358.0	-.4	8380.7	26.4	343.8	.01
32K	109.42?	.0	-1.3	.0	81.7	343.8	.10
E3234	109.41?	-425.9	-.4	9970.2	26.4	343.8	.00
E3242	110.48?	-103.5	-4.6	2422.9	289.7	344.4	-.05
31A	109.47?	.0	-72.7	.0	4584.0	343.8	.40
E3100	109.21?	-5706.1	-15.9	133578.2	1001.5	343.7	-.38
31B	109.33?	.0	-98.8	.0	6229.7	343.7	.67
T3148	109.33?	-293.6	-5.1	6873.1	324.3	343.7	-.59
E3160	109.20?	-1500.3	-56.3	35121.6	3548.7	343.7	-.46
T3161	108.93?	-427.1	-8.8	9998.3	553.2	343.5	.01
T3165	108.91?	-95.1	-5.0	2226.3	316.5	343.5	-.08
E3240	109.96?	-211.8	-4.2	4958.2	264.9	344.1	-.06
31AA	110.01?	.0	-35.5	.0	2243.4	344.2	.09
35GA	123.24?	.0	-16.6	.0	1071.8	351.9	.09
E3540	123.23?	-143.3	-.3	3354.6	20.4	351.9	-.05
E3552	123.00?	-192.9	-6.1	4515.7	391.9	351.7	-.09
35KA	121.62?	.0	-34.1	.0	2200.9	351.0	-.70
E3570	121.62?	-1007.2	-2.9	23578.3	189.8	351.0	.69
E3549	120.53?	-10457.4	-22.7	244804.8	1463.3	350.3	-.32
E3566	121.78?	-137.2	-.8	3211.8	50.4	351.1	-.02
E3330	124.98?	-5535.6	-8.3	129586.8	538.2	352.9	1.11
P3148	346.64?	.0	-761.8	.0	62950.0	434.7	1.34
E3148	124.98?	-26000.0	-616.9	608652.6	40065.1	352.8	2.04
T1	348.81?	.0	-1518.7	.0	62844.3	435.3	-.99
T2	347.04?	.0	-1746.9	.0	72197.1	434.8	-1.49
TP2	125.00	.0	-191.7	.0	6225.9	352.9	.51
AEH	122.62?	-25000.0	-191.7	292621.5	6199.0	351.5	-.52
P4160	349.90?	.0	-534.9	.0	44307.8	435.6	-.44
E4160	60.00	.0	-126.1	.0	6993.8	307.3	-1.03
E4162	59.99?	-68.8	-6.1	1610.6	339.1	307.3	.29
E4810	58.98?	-414.4	-39.0	9701.0	2153.4	306.4	.10
44A	59.28?	.0	-219.0	.0	12115.4	306.7	1.01
44B	59.12?	.0	-33.7	.0	1864.7	306.5	.04
E4465	58.96?	-914.6	-4.7	21410.5	258.7	306.4	-.05
E4470	58.88?	-782.5	-9.4	18318.1	517.9	306.3	-.05
44C	59.21?	.0	-105.5	.0	5833.4	306.6	.07
E4430	58.97?	-782.5	-9.4	18318.1	518.2	306.4	-.04
44D	59.18?	.0	-89.5	.0	4946.3	306.6	-.04
E4140	59.16?	-247.6	-57.6	5796.2	3185.6	306.6	-.10
44E	59.17?	.0	-30.8	.0	1702.4	306.6	.17
E4405	59.17?	.0	-4.7	.0	260.1	306.6	-.13
E4410	59.11?	-342.6	-9.4	8020.2	519.9	306.5	-.04
44F	59.10?	.0	-142.4	.0	7873.1	306.5	.21
E4620	58.83?	-1058.9	-75.7	24788.5	4180.4	306.3	-.16
44G	58.39?	.0	-62.0	.0	3420.9	305.9	.09
44H	58.26?	.0	-31.6	.0	1743.9	305.7	.09
E4480	58.19?	-741.5	-3.5	17358.3	193.2	305.7	-.04
E4475	58.12?	-698.4	-7.0	16349.3	386.3	305.6	-.14

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESIDUAL (lbm/hr)
44I	58.20?	.0	-53.8	.0	2966.3	305.7	.26
E4455	57.96?	-781.8	-9.3	18301.7	514.1	305.5	-.03
E4460	58.09?	-781.8	-4.7	18301.7	257.3	305.6	-.41
44J	56.83?	.0	-58.5	.0	3208.5	304.4	-.04
44K	56.16?	.0	-30.7	.0	1678.6	303.8	-.01
44L	55.61?	.0	-54.9	.0	2995.8	303.2	.02
E4420	56.04?	-414.0	-13.9	9691.6	761.0	303.6	-.04
44M	55.58?	.0	-14.4	.0	785.1	303.2	.04
E4415	55.47?	-509.5	-9.2	11927.2	504.8	303.1	-.05
42A	46.04?	.0	-75.7	.0	3980.0	293.5	.07
42B	45.68?	.0	-34.0	.0	1786.3	293.1	-.02
E4227	45.66?	-647.4	-2.4	15155.4	128.2	293.1	.05
42C	45.26?	.0	-56.0	.0	2935.0	292.7	-.17
E4228	45.26?	-229.1	-2.4	5363.2	127.8	292.7	.14
E4229	45.01?	-647.4	-29.2	15155.4	1529.7	292.4	-.10
42D	44.66?	.0	-48.0	.0	2508.9	292.0	.00
E4224	44.65?	-229.1	-4.9	5363.2	254.2	292.0	-.01
42E	43.86?	.0	-53.0	.0	2761.9	291.2	.04
E4223	43.76?	-454.8	-21.8	10646.7	1133.8	291.0	-.07
42F	43.65?	.0	-45.9	.0	2389.0	290.9	-.02
E4222	43.61?	-647.3	-4.8	15153.1	251.4	290.9	-.01
E4221	43.60?	-229.1	-29.0	5363.2	1509.7	290.9	-.07
E4435	56.69?	-630.3	-8.1	14755.1	445.8	304.3	-.04
E4440	56.76?	-598.8	-4.6	14017.7	254.9	304.3	-.03
44IA	57.91?	.0	-62.5	.0	3439.1	305.4	.15

(6)

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
E5126	51A		4233.9	427.39	366247.1	8.00	1.64E+5	1.82E-2
51A	51B		2464.7	110.98	95170.1	4.00	1.91E+5	1.98E-2
51B	E5116		52.2	16.60	14227.6	1.00	1.62E+4	3.20E-2
51B	E5100		2289.6	71.01	60891.1	4.00	1.77E+5	1.99E-2
51A	51C		1393.6	146.60	125637.5	4.00	1.08E+5	2.09E-2
51C	E5106		632.3	46.37	39766.9	2.00	9.79E+4	2.35E-2
51C	51D		588.6	106.62	91364.1	4.00	4.56E+4	2.34E-2
51D	E5103		464.5	92.77	79529.9	2.00	7.19E+4	2.41E-2
E5126	51E		2764.7	140.36	120954.4	3.00	2.85E+5	2.05E-2
51E	E5137		301.1	3.29	2837.4	1.00	9.33E+4	2.71E-2
51E	E5135		237.9	9.89	8509.7	1.00	7.37E+4	2.74E-2
51E	51F		2115.8	18.38	18029.2	1.50	4.37E+5	2.36E-2
51F	E5232		622.7	3.08	2790.5	1.00	1.93E+5	2.64E-2
51F	51G		1447.8	24.54	22246.9	1.50	2.99E+5	2.38E-2
51G	E5234		561.6	3.07	2762.7	1.00	1.74E+5	2.65E-2
51G	E5236		820.8	60.36	52890.3	1.50	1.70E+5	2.42E-2
E5126	51H		18962.7	418.03	360104.2	8.00	7.34E+5	1.63E-2
51H	51I		1317.2	56.66	48838.0	2.00	2.04E+5	2.26E-2
51I	E5140		1055.0	2.61	2268.1	1.50	2.18E+5	2.40E-2
51I	E5141		187.6	42.29	36293.6	1.50	3.88E+4	2.69E-2
51H	51HA		17341.8	82.25	70782.6	8.00	6.72E+5	1.64E-2
52A	E5246		1180.1	22.85	19601.7	3.00	1.22E+5	2.16E-2
52A	52B		14676.4	253.66	218058.8	8.00	5.68E+5	1.65E-2
52B	52C		2955.1	391.55	335835.0	8.00	1.14E+5	1.91E-2
52C	E5422		331.5	85.39	73246.5	2.00	5.13E+4	2.50E-2
52C	E5265		2299.5	123.87	106315.3	4.00	1.78E+5	1.99E-2
E5265	E5266		40.2	6.62	5676.6	1.25	9.96E+3	3.41E-2
E5126	51J		5011.9	39.51	33877.8	6.00	2.59E+5	1.82E-2
51J	E5165		1144.7	270.99	232238.1	4.00	8.87E+4	2.13E-2
51J	51K		3654.8	49.07	42520.4	3.00	3.77E+5	2.03E-2
51K	E5175		26.7	5.30	4546.5	1.50	5.52E+3	3.84E-2
51K	51KA		3569.6	15.09	13067.5	3.00	3.69E+5	2.03E-2
E5126	51L		36960.4	494.13	427685.5	10.00	1.14E+6	1.54E-2
51L	51M		7044.7	156.78	148442.2	3.00	7.27E+5	1.99E-2
51M	E5101		2739.6	7.31	6362.7	3.00	2.83E+5	2.05E-2
51M	E5146		132.8	20.62	17845.0	2.00	2.06E+4	2.85E-2
51M	51N		3907.0	185.88	164541.2	3.00	4.03E+5	2.02E-2
51N	51O		3786.6	14.21	12579.3	3.00	3.91E+5	2.02E-2
51M	E5181		57.7	1.60	1383.3	1.00	1.79E+4	3.15E-2
51O	E5180		360.2	18.52	16337.9	1.00	1.12E+5	2.69E-2
51O	E5183		539.7	21.70	18860.6	3.00	5.57E+4	2.34E-2
51O	51P		2789.1	100.24	87871.1	3.00	2.88E+5	2.05E-2
51P	E5027		959.4	4.92	4356.6	1.50	1.98E+5	2.40E-2
51P	E5026		1743.1	28.30	27992.0	1.50	3.60E+5	2.37E-2
51L	E5185		29372.9	383.72	330698.1	10.00	9.10E+5	1.55E-2
E5185	51R		17453.7	384.93	330510.9	10.00	5.41E+5	1.59E-2
51R	E5188		1980.3	115.04	98713.8	4.00	1.53E+5	2.02E-2
51R	56A		14972.5	449.42	385528.6	14.00	3.31E+5	1.58E-2
56A	E5604		2794.9	17.69	15187.4	4.00	2.16E+5	1.97E-2
56A	56B		291.3	110.37	94674.9	3.00	3.01E+4	2.57E-2
56B	E5609		203.8	17.79	15258.3	2.00	3.16E+4	2.66E-2
56A	56C		11520.4	95.56	81972.4	16.00	2.23E+5	1.63E-2
56C	56D		6824.2	535.43	459413.4	8.00	2.64E+5	1.74E-2
56D	56E		770.9	176.99	151836.3	4.00	5.97E+4	2.24E-2

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
56E	E5648		594.9	127.84	109761.9	2.00	9.21E+4	2.36E-2
56D	57A		5565.7	216.29	185719.3	6.00	2.87E+5	1.80E-2
57A	E5707		1865.4	3.80	3262.5	3.00	1.93E+5	2.09E-2
57A	E5703		3506.1	120.06	104175.6	3.00	3.62E+5	2.03E-2
56C	56F		4026.9	660.28	566353.3	16.00	7.80E+4	1.93E-2
56F	56G		-2019.4	176.57	151453.3	10.00	6.26E+4	2.07E-2
56G	56H		-2167.0	80.26	68842.5	10.00	6.71E+4	2.04E-2
56H	56I		-2323.3	176.57	151454.0	10.00	7.20E+4	2.02E-2
56I	E5365		390.3	17.17	14726.5	2.50	4.84E+4	2.44E-2
56I	56J		-2902.2	136.44	117033.0	10.00	8.99E+4	1.94E-2
56J	55A		7018.0	311.60	272204.8	4.00	5.44E+5	1.89E-2
55A	E5560		693.8	5.21	4501.5	1.50	1.43E+5	2.44E-2
56J	52B		-10526.8	722.25	619653.6	10.00	3.26E+5	1.65E-2
52B	E5307		386.2	199.14	170866.5	2.00	5.98E+4	2.46E-2
55A	E5590		58.1	69.99	60220.2	4.00	4.50E+3	3.96E-2
55A	54A		5841.3	417.06	363487.6	4.00	4.52E+5	1.90E-2
54A	54B		815.2	241.99	208886.8	4.00	6.31E+4	2.23E-2
54B	E5425		86.6	5.17	4461.9	1.50	1.79E+4	3.01E-2
54B	E5427		551.7	62.45	53944.8	2.00	8.55E+4	2.38E-2
54A	54C		4635.6	77.32	67109.5	4.00	3.59E+5	1.91E-2
54C	E5452		827.2	6.93	5989.4	2.00	1.28E+5	2.31E-2
54C	54D		3566.0	356.37	308804.1	4.00	2.76E+5	1.94E-2
54D	E5360		2198.6	36.82	31929.6	3.00	2.27E+5	2.07E-2
E5360	E5357		388.5	27.60	23868.3	2.00	6.02E+4	2.46E-2
54D	E5352		1084.6	128.90	111436.1	4.00	8.40E+4	2.14E-2
E5352	E5354		460.5	36.94	31935.7	3.00	4.76E+4	2.39E-2
56F	56K		4693.8	1825.97	1566581.0	8.00	1.82E+5	1.80E-2
56K	E5685		1867.1	14.03	12194.3	2.00	2.89E+5	2.23E-2
56K	E5695		1813.3	142.68	122408.1	6.00	9.36E+4	2.02E-2
E5695	E5697		316.7	199.01	170773.3	2.00	4.91E+4	2.51E-2
51KA	E5179		2850.6	83.21	71781.4	3.00	2.94E+5	2.04E-2
51KA	E5173		644.6	2.64	2271.8	1.50	1.33E+5	2.44E-2
E5126	E5125		70.1	13.29	11387.8	1.50	1.45E+4	3.12E-2
51HA	E5244		1056.5	5.23	4545.7	1.50	2.18E+5	2.40E-2
51HA	52A		16118.5	198.81	170996.8	8.00	6.24E+5	1.64E-2
E3312	33A		2308.1	62.84	54609.0	5.00	1.43E+5	1.96E-2
33A	E3320		320.4	1.66	1439.5	2.50	3.97E+4	2.51E-2
33A	E3331		1925.9	17.02	14805.1	4.00	1.49E+5	2.02E-2
E3312	35A		9326.8	17.98	16650.1	5.00	5.78E+5	1.80E-2
35A	E3516		7549.0	10.28	9240.0	5.00	4.68E+5	1.81E-2
35A	E3510		1723.9	37.75	33036.7	3.00	1.78E+5	2.10E-2
E3516	35B		1510.6	11.41	10052.0	2.50	1.87E+5	2.17E-2
35B	E3500		311.0	2.59	2255.1	2.00	4.82E+4	2.52E-2
35B	E3514		1169.8	5.09	4507.9	2.00	1.81E+5	2.27E-2
E3514	35C		860.8	6.85	6005.1	2.00	1.33E+5	2.30E-2
35C	T3517		103.6	.63	545.7	1.50	2.14E+4	2.92E-2
35C	35D		731.7	3.43	3000.9	2.00	1.13E+5	2.33E-2
35D	T3518		104.9	.63	545.5	1.50	2.17E+4	2.91E-2
35D	35E		602.5	4.30	3750.2	2.00	9.33E+4	2.36E-2
35E	T3519		103.5	.63	545.4	1.50	2.14E+4	2.92E-2
35E	35F		474.3	4.30	3749.4	2.00	7.35E+4	2.41E-2
35F	T3521		108.6	.63	545.3	1.50	2.24E+4	2.90E-2
35F	35G		341.6	2.58	2249.4	2.00	5.29E+4	2.49E-2
35G	T3523		110.1	.63	545.3	1.50	2.27E+4	2.89E-2

(8)

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
35G	E3525		205.7	8.62	7497.6	2.00	3.19E+4	2.66E-2
E3516	35GA		1363.5	21.65	18878.5	3.00	1.41E+5	2.13E-2
35H	35I		661.8	3.62	3144.5	3.00	6.83E+4	2.28E-2
35I	E3550		411.4	5.43	4716.6	3.00	4.25E+4	2.43E-2
35H	35J		466.8	13.82	12028.3	2.00	7.23E+4	2.41E-2
35J	E3546		215.0	5.48	4780.4	1.25	5.33E+4	2.69E-2
35J	E3544		220.0	3.77	3279.4	1.50	4.54E+4	2.65E-2
E3544	E3542		107.5	3.77	3279.0	1.50	2.22E+4	2.88E-2
E3312	33B		15783.5	22.83	20157.4	8.00	6.11E+5	1.64E-2
33B	T3360		250.8	.39	342.7	1.00	7.77E+4	2.74E-2
33B	33C		15473.4	52.19	46051.5	8.00	5.99E+5	1.65E-2
33C	T3370		182.8	3.13	2738.4	1.00	5.66E+4	2.79E-2
33C	36A		15208.7	66.85	58958.7	8.00	5.89E+5	1.65E-2
36A	E3615		717.5	9.77	8740.6	1.50	1.48E+5	2.43E-2
36A	E3622		22.2	3.55	3080.1	1.00	6.87E+3	3.74E-2
36A	36B		14381.0	55.50	48856.5	8.00	5.57E+5	1.65E-2
36B	35K		12198.9	42.57	38946.8	6.00	6.30E+5	1.73E-2
35K	35L		562.3	5.30	4606.9	4.00	4.35E+4	2.36E-2
35L	E3563		157.4	2.71	2354.6	3.00	1.63E+4	2.90E-2
E3563	E3567		49.8	1.18	1023.7	1.00	1.54E+4	3.22E-2
35L	35M		373.8	13.78	11977.7	4.00	2.89E+4	2.53E-2
35M	E3560		343.6	7.22	6278.8	3.00	3.55E+4	2.50E-2
36B	37A		2052.8	119.04	103426.5	8.00	7.95E+4	2.01E-2
37A	E3726		1104.9	23.37	20314.6	4.00	8.56E+4	2.14E-2
E3726	E3728		219.8	12.12	10532.4	2.00	3.40E+4	2.63E-2
E3726	E3724		350.7	11.77	10225.0	3.00	3.62E+4	2.50E-2
37A	E3580		666.5	56.09	48759.8	3.00	6.88E+4	2.28E-2
37A	E3835		92.0	141.71	123124.7	6.00	4.75E+3	3.86E-2
E3312	E3081		4383.5	424.52	369763.4	6.00	2.26E+5	1.84E-2
E3312	E3330		5565.6	16.57	14400.1	8.00	2.16E+5	1.77E-2
E3312	33D		20539.9	32.60	36920.3	6.00	1.06E+6	1.71E-2
33D	E3348		115.0	1.25	1090.6	1.50	2.38E+4	2.87E-2
33D	33E		20381.6	7.18	8174.3	6.00	1.05E+6	1.71E-2
33E	E3334		60.2	13.49	11742.6	3.00	6.21E+3	3.64E-2
33E	33F		20285.3	18.69	21404.9	6.00	1.05E+6	1.71E-2
33F	E3329		251.9	3.43	3047.7	1.00	7.80E+4	2.74E-2
E3329	E3328		187.4	3.87	3380.2	1.25	4.64E+4	2.72E-2
E3328	E3326		125.0	4.64	4054.2	1.25	3.10E+4	2.84E-2
E3326	E3325		56.9	7.43	6485.5	1.50	1.17E+4	3.25E-2
33F	32A		19981.0	41.22	47627.6	6.00	1.03E+6	1.71E-2
32A	32B		19503.6	1.32	1513.5	6.00	1.01E+6	1.71E-2
32A	T3265		435.1	4.43	3868.4	3.00	4.49E+4	2.41E-2
32B	32C		4573.1	20.15	18145.3	4.00	3.54E+5	1.92E-2
32C	E3266		288.6	1.52	1342.6	1.25	7.15E+4	2.63E-2
32C	32D		4251.7	6.07	5438.0	4.00	3.29E+5	1.92E-2
32D	E3266		137.3	7.37	6443.1	1.50	2.83E+4	2.80E-2
32D	E3226		4086.5	5.07	4529.9	4.00	3.16E+5	1.93E-2
E3226	E3224		1328.0	4.07	3688.0	2.00	2.06E+5	2.26E-2
E3224	E3220		2178.9	16.42	14629.8	3.00	2.25E+5	2.07E-2
E3220	E3222		-992.7	45.87	40140.7	6.00	5.13E+4	2.22E-2
E3222	32E		-342.8	3.44	3010.6	6.00	1.77E+4	2.78E-2
32F	E3222		3575.3	3.25	3078.9	3.00	3.69E+5	2.03E-2
32F	32E		10583.3	18.70	17067.8	6.00	5.46E+5	1.74E-2
32B	32G		14885.0	30.81	30220.4	6.00	7.69E+5	1.72E-2

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
32G	32F		14195.6	14.53	14071.7	6.00	7.33E+5	1.72E-2
32G	E3244		628.7	38.77	33922.7	3.00	6.49E+4	2.30E-2
32E	32L		1499.1	1.75	1538.7	3.00	1.55E+5	2.12E-2
32L	32H		1750.4	26.09	23059.3	3.00	1.81E+5	2.10E-2
32H	E3228		372.7	.84	734.6	2.00	5.77E+4	2.47E-2
32H	32I		1344.0	3.93	3455.6	3.00	1.39E+5	2.13E-2
32I	E3230		455.3	.84	734.5	2.00	7.05E+4	2.42E-2
32I	32J		864.2	7.44	6526.4	3.00	8.92E+4	2.22E-2
32J	E3232		376.8	.84	734.4	2.00	5.84E+4	2.46E-2
32J	32K		464.4	1.75	1535.5	3.00	4.80E+4	2.39E-2
32K	E3234		444.6	.84	734.4	2.00	6.89E+4	2.42E-2
E3222	E3242		126.5	9.17	8027.5	1.50	2.61E+4	2.83E-2
32L	E3222		-286.1	5.04	4415.3	2.00	4.43E+4	2.54E-2
32E	31AA		8700.9	31.34	28084.2	6.00	4.49E+5	1.76E-2
31A	E3100		5739.9	31.79	28035.5	6.00	2.96E+5	1.80E-2
31A	31B		2581.2	82.27	72098.7	6.00	1.33E+5	1.93E-2
31B	T3148		316.5	10.29	9011.1	6.00	1.63E+4	2.82E-2
31B	E3160		2146.9	105.12	92103.1	6.00	1.11E+5	1.97E-2
E3160	T3161		572.4	7.52	6605.0	2.00	8.87E+4	2.37E-2
E3226	E3224		1328.0	4.07	3688.0	2.00	2.06E+5	2.26E-2
T3161	T3165		118.3	10.05	8804.4	2.00	1.83E+4	2.91E-2
35I	E3552		219.1	12.11	10526.4	2.00	3.39E+4	2.63E-2
35K	35KA		11584.1	16.88	15349.9	6.00	5.98E+5	1.74E-2
35KA	E3570		1030.9	5.88	5114.5	6.00	5.32E+4	2.20E-2
35KA	E3549		10499.7	45.43	40879.2	6.00	5.42E+5	1.74E-2
E3560	E3566		158.1	1.56	1364.6	1.00	4.90E+4	2.82E-2
31AA	31A		8412.5	31.36	28055.8	6.00	4.34E+5	1.76E-2
31AA	E3240		234.3	8.40	7351.2	2.00	3.63E+4	2.61E-2
35GA	35H		1162.7	10.83	9434.7	3.00	1.20E+5	2.16E-2
35GA	E3540		163.9	.63	547.0	1.50	3.38E+4	2.74E-2
P5126	T1		55076.4	1067.15	845837.9	12.00	1.42E+6	1.60E-2
T1	T2		53506.0	1970.17	1561892.0	12.00	1.38E+6	1.60E-2
T2	P3148		26283.9	1523.55	1206423.0	12.00	6.79E+5	1.64E-2
TP2	AEH		25211.4	383.45	340149.8	8.00	9.76E+5	1.62E-2
E3148	E3312		-1171.2	1233.82	1071092.0	8.00	4.54E+4	2.23E-2
P5126	P4160		15702.2	1069.90	846121.1	12.00	4.05E+5	1.68E-2
E4160	E4162		86.4	12.23	11065.4	2.00	1.34E+4	3.10E-2
E4160	E4810		464.5	77.94	70691.5	2.00	7.19E+4	2.41E-2
E4160	44A		14427.7	162.08	149323.5	8.00	5.59E+5	1.65E-2
44A	44B		1777.8	39.34	35694.0	4.00	1.38E+5	2.04E-2
44B	E4465		930.2	9.36	8514.5	2.50	1.15E+5	2.23E-2
44B	E4470		802.8	18.75	17026.6	2.50	9.95E+4	2.26E-2
44A	44C		1756.6	161.89	146596.2	6.00	9.07E+4	2.03E-2
44C	E4430		802.8	18.76	17031.8	2.50	9.95E+4	2.26E-2
44C	44D		837.2	30.32	27455.9	4.00	6.48E+4	2.22E-2
44D	E4140		316.1	115.23	104323.3	4.00	2.45E+4	2.62E-2
44D	44E		420.6	33.36	30199.4	4.00	3.26E+4	2.48E-2
44E	E4405		15.6	9.41	8518.3	2.50	1.93E+3	5.02E-2
44E	E4410		363.0	18.81	17035.0	2.50	4.50E+4	2.46E-2
44A	44F		10662.2	74.73	68152.0	8.00	4.13E+5	1.68E-2
44F	E4620		1145.4	151.38	137167.5	4.00	8.87E+4	2.13E-2
44F	44G		9363.2	58.73	54875.5	6.00	4.83E+5	1.75E-2
44G	44H		1514.6	42.24	38319.1	4.00	1.17E+5	2.07E-2
44H	E4480		755.8	7.01	6367.0	2.50	9.37E+4	2.27E-2

(10)

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
44H	E4475		716.1	14.02	12732.6	2.50	8.87E+4	2.28E-2
44G	44I		7775.5	23.09	21305.9	6.00	4.01E+5	1.77E-2
44I	E4455		802.0	18.67	16970.1	2.50	9.94E+4	2.26E-2
44I	E4460		796.9	9.34	8486.9	2.50	9.88E+4	2.26E-2
44I	44IA		6111.7	56.54	51697.3	6.00	3.16E+5	1.79E-2
44J	44K		4705.9	23.04	21749.4	4.00	3.64E+5	1.91E-2
44K	44L		4226.2	10.49	10140.0	3.50	3.74E+5	1.96E-2
44K	E4420		438.4	27.83	25269.0	2.50	5.43E+4	2.41E-2
44L	44M		554.1	10.26	9318.7	3.00	5.72E+4	2.33E-2
44M	E4415		529.2	18.50	16809.8	2.50	6.56E+4	2.35E-2
44L	42A		3606.7	88.98	91500.4	3.00	3.72E+5	2.03E-2
42A	42B		1692.9	14.47	13432.2	3.00	1.75E+5	2.10E-2
42B	E4227		658.9	4.88	4473.7	3.00	6.80E+4	2.28E-2
42B	42C		990.9	48.67	44696.9	3.00	1.02E+5	2.19E-2
42C	E4228		240.7	4.88	4465.4	3.00	2.49E+4	2.67E-2
42C	E4229		685.5	58.41	53555.0	3.00	7.08E+4	2.27E-2
42A	42D		1829.0	47.87	44672.4	3.00	1.89E+5	2.09E-2
42D	E4224		242.8	9.72	8906.6	3.00	2.51E+4	2.66E-2
42D	42E		1529.3	38.35	35562.7	3.00	1.58E+5	2.11E-2
42E	E4223		485.3	43.53	39925.9	3.00	5.01E+4	2.38E-2
42E	42F		982.2	24.11	22175.3	3.00	1.01E+5	2.19E-2
42F	E4222		660.9	9.66	8864.9	3.00	6.82E+4	2.28E-2
42F	E4221		266.8	58.00	53189.0	3.00	2.75E+4	2.61E-2
44J	E4435		649.1	16.26	14776.8	2.50	8.04E+4	2.30E-2
44J	E4440		614.1	9.30	8445.0	2.50	7.61E+4	2.32E-2
44IA	44J		6038.2	68.40	63727.2	5.00	3.74E+5	1.83E-2

COMPUTED VALVE AND REGULATOR FLOWS AND PARAMETERS

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	Cs
P5126	E5126	?	68774.8	198.0
P3148	E3148	?	25468.3	72.5
P4160	E4160	?	15114.8	41.5
T2	TP2	?	25424.2	72.3

COMPUTED TRAP LOSSES

15 percent trap leakage rate

Trap Steam Losses	Trap Heat Losses
4781.2 lbs/hr	5702870.0 Btus/hr

APG - Alternative 3
Consolidate E5126,E4160,E4225 and close Steam Loop

SYSTEM MASS FLOWS

(1)	Steam to loads:	171276.	lbm/hr
(2)	Steam condensed in pipes:	24620.	lbm/hr
(3)	Steam condensed in vaults:	0.	lbm/hr
(4)	Steam lost to trap leakage:	4781.	lbm/hr
(5)	Total steam plant output:	200677.	lbm/hr
(6)	Pipe and vault condensate returned:	14276.	lbm/hr
(7)	Load condensate returned:	118189.	lbm/hr
(8)	Total condensate returned:	132465.	lbm/hr

SYSTEM HEAT LOSSES AND DISTRIBUTION EFFICIENCY
(M = Million)

(1)	Total pipe conduction heat losses:	21.021	MBtus/hr	57.62 %
(2)	Total pipe condensate heat losses:	3.541	MBtus/hr	9.71 %
(3)	Total load condensate heat losses:	6.214	MBtus/hr	17.03 %
(4)	Total vault conduction heat losses:	.000	MBtus/hr	.00 %
(5)	Total vault condensate heat losses:	.000	MBtus/hr	.00 %
(6)	Total trap heat losses:	5.703	MBtus/hr	15.63 %
(7)	Total heat losses:	36.479	MBtus/hr	100.00 %
(8)	Total heat to loads:	184.143	MBtus/hr	
(9)	Total heat input to supply:	241.077	MBtus/hr	
(10)	Total heat returned to plant:	13.834	MBtus/hr	
(11)	Net heat input from plant:	227.243	MBtus/hr	

DISTRIBUTION EFFICIENCY: 83.9% [1.0-(7)/(11)]

(12)

Appendix C: Cooling Equipment at Buildings E3081, E3100, E3510, and E3516

APG COOLING DATA

BLDG E3510

*McQuay
Model # AHP033CT
Nominal Rating 33 Tons
Serial # D322825
Condenser Fans 2 ea. 4.5 F.L.A. 26.0 L.R.A.
Compressor 2 ea. 32.0 F.L.A. 160.0 L.R.A.
460 v 60 Hz 3 Phase

*McQuay
Model # AHP040CT
Nominal Rating 40 Tons
Serial # 3JF00513-09
Condenser Fans 2 ea. 4.5 F.L.A. 26 L.R.A.
Compressor 2 ea. 38.0 F.L.A. 214 L.R.A.
460 v 60 Hz 3 Phase

BLDG E3516

*Window AC Units
Nominal Rating 29000 Btu/unit
15.1 Amps/unit
220.0 Volts/unit
40 Units

*Model # 50QJ006500
Nominal Rating 5 Tons
Serial # 0389G20320
22.0 F.L.A. 220 v

*Nominal Rating 3 Tons
13.2 R.L.A. 220 v

*Continental
Model # DBA-52F
Nominal Rating 52 Tons
Serial # 120789-050790
Fans 2.1 F.L.A. .75 Hp
1.6 F.L.A. .75 Hp
Comp. Oil Heater 180 watts
Chill Evap. Heater 250 watts
Unit Ampacity 92 amps
115 v 35.6 R.L.A.

*Nominal Rating 2.5 Tons
Fan 2.1 F.L.A.
220 v 14.0 R.L.A.

BLDG E3100

*Nominal Rating 350 Tons
4160 v 44 F.L.A.
Water Cooled

*Nominal Rating 350 Tons
4160 v 44 F.L.A.
Water Cooled

*York
Nominal Rating 150 Tons
460 v 180 F.L.A.
Air Cooled

*York
Nominal Rating 150 Tons
460 v 180 F.L.A.
Air Cooled

BLDG E3081

*York
Nominal Rating 350 Tons
460 v 416 F.L.A.
Water Cooled

*York
Nominal Rating 350 Tons
460 v 416 F.L.A.
Water Cooled

*York
Nominal Rating 250 Tons
460 v 267 F.L.A.
Water Cooled

*York
Nominal Rating 250 Tons
460 v 267 F.L.A.
Water Cooled

*Cooling Tower
460 v 20 F.L.A.

*Cooling Tower
460 v 20 F.L.A.

Appendix D: Life Cycle Cost Analyses

LCCID 1.072 DATE/TIME: 12-15-93 15:51:49
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 1 STATUS QUO E5126
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JUL 93
MIDPOINT OF CONSTRUCTION (MPC)	OCT 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	OCT 93
ELECTRICITY	16187.3	.84	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
DISTILLATE OIL	258856.1	2.66	JUL94-JUL18
WINTER STEAM	1874620.0	2.66	JUL94-JUL18
SUMMER STEAM	537629.0	.84	JUL94-JUL18
MAINT LABOR	637939.0	.00	JUL94-JUL18
MAINT SERV	22036.0	.00	JUL94-JUL18
MAINT SUPPLY	5926.0	.00	JUL94-JUL18
MAINT UTIL	69379.0	.00	JUL94-JUL18
PERMIT & TESTING	60000.0	*******	JAN97-JAN18
BOILER MAINT	86786.0	*******	JAN09-JAN09
STACK MAINT	6941.0	*******	JAN04-JAN14
WATER TREAT. MAINT	20000.0	*******	JAN04-JAN14
FEEDWATER PUMP MAINT	16538.0	*******	JAN09-JAN09
OIL PUMP MAINT	4855.0	*******	JAN99-JAN19
DRUMCTL	5000.0	.00	JAN 93
DRUMCTL	5000.0	.00	JAN 07
ECONOMIZER	49875.0	.00	JAN 07
RELVALVE	1577.0	.00	JAN 07
RELVALVE	20090.0	.00	JAN 93
RELVALVE	1985.0	.00	JAN 07

WTBOILER	3625000.0	.00	JAN 93
PUMPSIMPLEX	6000.0	.00	JAN 08
PUMPSIMPLEX	9000.0	.00	JAN 12
PUMPSIMPLEX	3000.0	.00	JAN 07
TANKSTEEL	1000.0	.00	JAN 08
TANKSTEEL	1500.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 07
BOILMASTER	5000.0	.00	JAN 17
FLOWMETER	3100.0	.00	JAN 17
PSIGCTRL	2600.0	.00	JAN 17
PSIGSENSOR	1100.0	.00	JAN 17
TEMPREC	3100.0	.00	JAN 17
CONDPUMP	12500.0	.00	JAN 12
CONDREC	14000.0	.00	JAN 13
FEEDPUMP	49500.0	.00	JAN 13
OILPIPEABOVE	1400.0	.00	JAN 93
OILPIPEBELOW	2600.0	.00	JAN 93
PUMP	9000.0	.00	JAN 08
TANKABOVE	166000.0	.00	JAN 93
UNLOADPUMP	7300.0	.00	JAN 93
FLASHTANK	380.0	.00	JAN 12
HEATEXCH	1750.0	.00	JAN 15
SZSOFT	115500.0	.00	JAN 07

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	1077.0	.0	JAN94-JAN19
DIST	4.78	54154.0		JAN94-JAN19
WSTM	8.60	217979.0		JAN94-JAN19
SSTM	8.60	62515.0		JAN94-JAN19

LCCID 1.072 DATE/TIME: 12-15-93 15:51:49
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 1 STATUS QUO E5126
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		0.
ENERGY COSTS:		
ELECTRICITY	277839.	
DISTILLATE OIL	5523002.	
PURCHASED WINTER STEAM	39997228.	
PURCHASED SUMMER STEAM	9227871.	
TOTAL ENERGY COSTS		55025940.
ROUTINE M&R/CUSTODIAL COSTS		11486600.
MAJOR REPAIR/REPLACEMENT COSTS		548370.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		67060910.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 12-15-93 15:51:49
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 1 STATUS QUO E5126
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 0.

BENEFICIAL OCCUPANCY DATE: JAN94
ANNUAL PAYMENTS OCCUR: JUL94 THROUGH JUL18

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	15692.	252744.	1830357.	521171.	707000.	0.
2	15208.	249411.	1806216.	505108.	679808.	0.
3	14652.	248406.	1798939.	486637.	653661.	0.
4	14114.	248539.	1799905.	468754.	628520.	52304.
5	13658.	248528.	1799822.	453610.	604347.	0.
6	13248.	248800.	1801795.	440021.	581103.	3913.
7	12982.	248900.	1802517.	431166.	558752.	46498.
8	12674.	247422.	1791811.	420944.	537262.	0.
9	12337.	244710.	1772177.	409762.	516598.	0.
10	12000.	241095.	1745991.	398554.	496729.	41337.
11	11663.	236675.	1713987.	387349.	477624.	21063.
12	11364.	232064.	1680590.	377448.	459254.	0.
13	10998.	226961.	1643638.	365282.	441590.	36748.
14	10646.	221745.	1605864.	353597.	424606.	104495.
15	10296.	216594.	1568562.	341951.	408275.	9060.
16	9955.	211733.	1533357.	330623.	392572.	91570.
17	9644.	206149.	1492915.	320312.	377473.	0.
18	9335.	201440.	1458813.	310032.	362955.	0.
19	9031.	197126.	1427572.	299935.	348995.	40359.
20	8737.	192846.	1396578.	290175.	335572.	29555.
21	8453.	188603.	1365850.	280741.	322666.	14229.
22	8178.	184401.	1335423.	271624.	310255.	26572.
23	7913.	180244.	1305312.	262811.	298322.	0.
24	7656.	176133.	1275545.	254291.	286849.	5928.
25	7406.	171735.	1243691.	245974.	275816.	22953.
***	277839.	5523002.	********	9227871.	********	548370.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLL

LCCID 1.072 DATE/TIME: 12-15-93 14:38:56
PROJECT NO., FY, & TITLE: FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 1 STATUS QUO E3312
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JUL 93
MIDPOINT OF CONSTRUCTION (MPC)	OCT 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	OCT 93
ELECTRICITY	16878.7	.84	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
DISTILLATE OIL	341593.2	2.66	JUL94-JUL18
WINTER STEAM	1874628.0	2.66	JUL94-JUL18
SUMMER STEAM	537629.0	.84	JUL94-JUL18
MAINT LABOR	150000.0	.00	JUL94-JUL18
MAINT SERV	23545.0	.00	JUL94-JUL18
MAINT SUPPLY	6130.0	.00	JUL94-JUL18
MAINT UTIL	72258.0	.00	JUL94-JUL18
PERMIT & TESTING	30000.0	*******	JAN97-JAN18
BOILER MAINT	216965.0	*******	JAN04-JAN19
STACK MAINT	6941.0	*******	JAN04-JAN14
WATER TREAT. MAINT	20000.0	*******	JAN04-JAN14
FEEDWATER PUMP MAINT	11025.0	*******	JAN09-JAN09
OIL PUMP MAINT	12138.0	*******	JAN99-JAN19
BREECH	27750.0	.00	JAN 15
STACK	10713.0	.00	JAN 15
DRUMCTL	15000.0	.00	JAN 08
DRUMCTL	10000.0	.00	JAN 95
FTBOILER	1450000.0	.00	JAN 00
FTBOILER	2306250.0	.00	JAN 13

FTBURNER	175500.0	.00	JAN 13
FW_REG	1400.0	.00	JAN 15
RELVALVE	16200.0	.00	JAN 08
RELVALVE	10800.0	.00	JAN 95
PUMPSIMPLEX	9000.0	.00	JAN 95
TANKSTEEL	3000.0	.00	JAN 95
BOILMASTER	15000.0	.00	JAN 18
BOILMASTER	10000.0	.00	JAN 05
FLOWMETER	3100.0	.00	JAN 05
PSIGCTRL	2600.0	.00	JAN 05
PSIGSENSOR	1100.0	.00	JAN 05
TEMPREC	3100.0	.00	JAN 05
CONDPUMP	14000.0	.00	JAN 12
CONDREC	27000.0	.00	JAN 05
DAIRHEATER	25000.0	.00	JAN 19
DAIRHEATER	31000.0	.00	JAN 17
FEEDPUMP	20000.0	.00	JAN 13
FEEDPUMP	20900.0	.00	JAN 13
OILPIPEBELOW	6500.0	.00	JAN 93
PUMP	22500.0	.00	JAN 00
TANKABOVE	83000.0	.00	JAN 93
UNLOADPUMP	9434.0	.00	JAN 93
SZSOFT	115500.0	.00	JAN 04

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	1123.0	.0	JAN94-JAN19
DIST	4.78	71463.0		JAN94-JAN19
WSTM	8.60	217980.0		JAN94-JAN19
SSTM	8.60	62515.0		JAN94-JAN19

LCCID 1.072 DATE/TIME: 12-15-93 14:38:56
PROJECT NO., FY, & TITLE: FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 1 STATUS QUO E3312
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		0.
ENERGY COSTS:		
ELECTRICITY	289706.	
DISTILLATE OIL	7288295.	
PURCHASED WINTER STEAM	39997408.	
PURCHASED SUMMER STEAM	9227871.	
TOTAL ENERGY COSTS		56803280.
ROUTINE M&R/CUSTODIAL COSTS		3935717.
MAJOR REPAIR/REPLACEMENT COSTS		2958875.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		63697870.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 12-15-93 14:38:56
PROJECT NO., FY, & TITLE: FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 1 STATUS QUO E3312
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 0.

BENEFICIAL OCCUPANCY DATE: JAN94
ANNUAL PAYMENTS OCCUR: JUL94 THROUGH JUL18

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	16362.	333528.	1830366.	521171.	242243.	0.
2	15858.	329129.	1806225.	505108.	232926.	30926.
3	15278.	327803.	1798947.	486637.	223968.	0.
4	14716.	327979.	1799914.	468754.	215353.	26152.
5	14241.	327964.	1799831.	453610.	207071.	0.
6	13814.	328323.	1801803.	440021.	199106.	9783.
7	13536.	328455.	1802525.	431166.	191448.	1164388.
8	13215.	326504.	1791819.	420944.	184085.	0.
9	12864.	322926.	1772186.	409762.	177005.	0.
10	12512.	318154.	1745999.	398554.	170197.	20668.
11	12161.	312323.	1713995.	387349.	163651.	246128.
12	11850.	306237.	1680597.	377448.	157357.	29874.
13	11468.	299504.	1643645.	365282.	151304.	18374.
14	11101.	292621.	1605872.	353597.	145485.	0.
15	10735.	285823.	1568570.	341951.	139889.	17667.
16	10380.	279408.	1533364.	330623.	134509.	28946.
17	10056.	272039.	1492922.	320312.	129336.	0.
18	9733.	265825.	1458820.	310032.	124361.	0.
19	9416.	260132.	1427578.	299935.	119578.	21298.
20	9110.	254484.	1396584.	290175.	114979.	1174105.
21	8814.	248885.	1365856.	280741.	110557.	17489.
22	8528.	243341.	1335429.	271624.	106304.	30063.
23	8251.	237854.	1305318.	262811.	102216.	0.
24	7983.	232430.	1275551.	254291.	98284.	12333.
25	7722.	226625.	1243697.	245974.	94504.	17215.
***	289706.	7288295.	********	9227871.	3935717.	2958875.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLL

LCCID 1.072 DATE/TIME: 12-15-93 14:42:50
PROJECT NO., FY, & TITLE: FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: STATUS QUO E4160
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JUL 93
MIDPOINT OF CONSTRUCTION (MPC)	OCT 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	OCT 93
ELECTRICITY	3006.0	.84	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
DISTILLATE OIL	261838.8	2.66	JUL94-JUL18
MAINT LABOR	4608.0	.00	JUL94-JUL18
MAINT SERV	10000.0	.00	JUL94-JUL18
MAINT SUPPLY	5000.0	.00	JUL94-JUL18
MAINT UTIL	12600.0	.00	JUL94-JUL18
PERMIT & TESTING	15000.0	*******	JAN97-JAN18
BOILER MAINT	86786.0	*******	JAN09-JAN09
STACK MAINT.	6941.0	*******	JAN04-JAN14
WATER TREAT MAINT	5000.0	*******	JAN04-JAN14
FEEDWATER PUMP MAINT	11025.0	*******	JAN09-JAN09
OIL PUMP MAINT	4855.0	*******	JAN99-JAN19
STACK	3636.0	.00	JAN 18
DRUMCTL	5000.0	.00	JAN 98
DRUMCTL	5000.0	.00	JAN 10
FTBOILER	339682.0	.00	JAN 03
FTBOILER	373637.0	.00	JAN 15
FTBURNER	26083.0	.00	JAN 03
FTBURNER	28257.0	.00	JAN 15
F_FAN	8625.0	.00	JAN 18

RELVALVE	1148.0	.00	JAN 98
RELVALVE	1800.0	.00	JAN 10
PUMPSIMPLEX	3000.0	.00	JAN 98
PUMPSIMPLEX	3000.0	.00	JAN 10
TANKPOLY	200.0	.00	JAN 98
TANKPOLY	200.0	.00	JAN 10
BOILMASTER	5000.0	.00	JAN 08
DAMPACT	1100.0	.00	JAN 08
FLAMESAFE	10000.0	.00	JAN 08
FLOWMETER	3100.0	.00	JAN 08
PSIGCTRL	2600.0	.00	JAN 08
PSIGSENSOR	1100.0	.00	JAN 08
TEMPREC	3100.0	.00	JAN 08
CONDPUMP	7000.0	.00	JAN 98
CONDREC	6000.0	.00	JAN 08
FWHEATER	17000.0	.00	JAN 18
OILPIPEABOVE	518.0	.00	JAN 00
OILPIPEBELOW	962.0	.00	JAN 93
PUMP	1000.0	.00	JAN 03
PUMP	1000.0	.00	JAN 15
TANKBELOW	40800.0	.00	JAN 93
UNLOADPUMP	5233.0	.00	JAN 93
FLASHTANK	580.0	.00	JAN 03
SZSOFT	70000.0	.00	JAN 10

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	200.0	.0	JAN94-JAN19
DIST	4.78	54778.0		JAN94-JAN19

LCCID 1.072 DATE/TIME: 12-15-93 14:42:50
PROJECT NO., FY, & TITLE: FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: STATUS QUO E4160
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		0.
ENERGY COSTS:		
ELECTRICITY	51595.	
DISTILLATE OIL	5586642.	
TOTAL ENERGY COSTS		5638237.
ROUTINE M&R/CUSTODIAL COSTS		503156.
MAJOR REPAIR/REPLACEMENT COSTS		663835.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		6805228.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 12-15-93 14:42:50
PROJECT NO., FY, & TITLE: FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: STATUS QUO E4160
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 0.

BENEFICIAL OCCUPANCY DATE: JAN94
ANNUAL PAYMENTS OCCUR: JUL94 THROUGH JUL18

PAY	ELECT	DIST	OPER'NL	CAPITAL
1	2914.	255656.	30969.	0.
2	2824.	252285.	29778.	0.
3	2721.	251268.	28633.	0.
4	2621.	251403.	27532.	13076.
5	2536.	251391.	26473.	13703.
6	2460.	251667.	25454.	3913.
7	2411.	251768.	24475.	12026.
8	2354.	250273.	23534.	0.
9	2291.	247530.	22629.	0.
10	2228.	243873.	21759.	263414.
11	2166.	239402.	20922.	11126.
12	2110.	234738.	20117.	0.
13	2042.	229576.	19343.	9187.
14	1977.	224300.	18599.	0.
15	1912.	219090.	17884.	18120.
16	1849.	214173.	17196.	64067.
17	1791.	208524.	16535.	41883.
18	1733.	203761.	15899.	0.
19	1677.	199397.	15287.	7261.
20	1622.	195068.	14699.	0.
21	1570.	190776.	14134.	7517.
22	1519.	186526.	13590.	179825.
23	1469.	182320.	13068.	0.
24	1422.	178163.	12565.	0.
25	1375.	173713.	12082.	16932.
***	51595.	5586642.	503156.	663835.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLL

LCCID 1.072 DATE/TIME: 12-15-93 14:41:10
PROJECT NO., FY, & TITLE: FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: STATUS QUO E4225
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JUL 93
MIDPOINT OF CONSTRUCTION (MPC)	OCT 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	OCT 93
ELECTRICITY	2254.5	.84	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
DISTILLATE OIL	125212.1	2.66	JUL94-JUL18
MAINT LABOR	18320.0	.00	JUL94-JUL18
MAINT SERV	10000.0	.00	JUL94-JUL18
MAINT SUPPLY	5000.0	.00	JUL94-JUL18
MAINT UTIL	6014.0	.00	JUL94-JUL18
PERMIT & TESTING	30000.0	*******	JAN97-JAN18
BOILER MAINT	86786.0	*******	JAN09-JAN09
STACK MAINT	6941.0	*******	JAN04-JAN14
WATER TREAT MAINT	5000.0	*******	JAN04-JAN14
FEEDWATER PUMP MAINT	27563.0	*******	JAN09-JAN09
OIL PUMP MAINT	7283.0	*******	JAN99-JAN19
STACK	10713.0	.00	JAN 02
DRUMCTL	15000.0	.00	JAN 93
FTBOILER	1019046.0	.00	JAN 93
FTBURNER	78249.0	.00	JAN 93
F_FAN	21000.0	.00	JAN 18
RELVALVE	3444.0	.00	JAN 93
PUMPSIMPLEX	9000.0	.00	JAN 05
TANKPOLY	600.0	.00	JAN 05

BOILMASTER	15000.0	.00	JAN 93
FLOWMETER	9300.0	.00	JAN 93
PSIGCTRL	7800.0	.00	JAN 93
PSIGSENSOR	3300.0	.00	JAN 93
TEMPREC	9300.0	.00	JAN 93
OILPIPEABOVE	1680.0	.00	JAN 11
PUMP	3000.0	.00	JAN 03
TANKBELOW	21500.0	.00	JAN 93
SZSOFT	115500.0	.00	JAN 05

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	150.0	.0	JAN94-JAN19
DIST	4.78	26195.0		JAN94-JAN19

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LCCID  1.072                    DATE/TIME:  12-15-93  14:41:10
PROJECT NO., FY, & TITLE:       FY 1993    ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL     MARYLAND
DESIGN FEATURE: STATUS QUO  E4225
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

                     LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS                                    0.

ENERGY COSTS:

ELECTRICITY                                       38696.
DISTILLATE OIL                                  2671549.

TOTAL ENERGY COSTS                                          2710245.

ROUTINE M&R/CUSTODIAL COSTS                                  614479.

MAJOR REPAIR/REPLACEMENT COSTS                               338104.

OTHER COSTS & MONETARY BENEFITS:

OTHER PRE-OCCUPANCY COSTS/BENEFITS                     0.
NET DISPOSAL COSTS OR RETENTION VALUE                  0.
OTHER CAPITAL COSTS/BENEFITS                           0.
OTHER OPERATIONAL COSTS/BENEFITS                       0.

TOTAL OTHER COSTS & MONETARY BENEFITS                             0.

LCC OF ALL COSTS/BENEFITS (NET PW)                          3662828.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92
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LCCID 1.072 DATE/TIME: 12-15-93 14:41:10
PROJECT NO., FY, & TITLE: FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: STATUS QUO E4225
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 0.

BENEFICIAL OCCUPANCY DATE: JAN94
ANNUAL PAYMENTS OCCUR: JUL94 THROUGH JUL18

PAY	ELECT	DIST	OPER'NL	CAPITAL
1	2185.	122256.	37821.	0.
2	2118.	120643.	36366.	0.
3	2041.	120157.	34968.	0.
4	1966.	120222.	33623.	26152.
5	1902.	120216.	32330.	0.
6	1845.	120348.	31086.	5870.
7	1808.	120396.	29891.	23249.
8	1765.	119681.	28741.	0.
9	1718.	118370.	27636.	7676.
10	1671.	116621.	26573.	22735.
11	1624.	114483.	25551.	12735.
12	1583.	112252.	24568.	79685.
13	1532.	109784.	23623.	18374.
14	1483.	107261.	22714.	0.
15	1434.	104770.	21841.	0.
16	1386.	102418.	21001.	82561.
17	1343.	99717.	20193.	0.
18	1300.	97439.	19416.	846.
19	1258.	95352.	18670.	14521.
20	1217.	93282.	17952.	0.
21	1177.	91230.	17261.	8603.
22	1139.	89197.	16597.	12909.
23	1102.	87186.	15959.	0.
24	1066.	85198.	15345.	0.
25	1031.	83070.	14755.	19510.
***	38696.	2671549.	614479.	338104.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLL

LCCID 1.072 DATE/TIME: 09-14-93 09:58:36
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT. 4 OPT. 1 - CURRENT COOLING METHOD
ALT. ID. A; TITLE: CUR
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 93
MIDPOINT OF CONSTRUCTION (MPC)	JAN 94
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 95
ANALYSIS END DATE (AED)	JAN 20

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JAN 94
ELECTRICITY	4118476.0	.84	JUL95-JUL19
ELECT DEMAND	.0	.00	JUL95-JUL19
DISTILLATE OIL	987495.4	2.66	JUL95-JUL19
WINTER STEAM	3753066.0	2.66	JUL95-JUL19
SUMMER STEAM	1071440.0	.84	JUL95-JUL19
WINDOW UNITS	46000.0	*******	JAN13-JAN13
CENTF CHILLER	30000.0	*******	JAN17-JAN17
CENTF CHILLER (33)	24000.0	*******	JAN12-JAN12
CENTF CHILLER (40)	26600.0	*******	JAN12-JAN12

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	274017.0	.0	JAN95-JAN20
DIST	4.78	206589.0		JAN95-JAN20
WSTM	8.60	436403.0		JAN95-JAN20
SSTM	8.60	124586.0		JAN95-JAN20

LCCID 1.072 DATE/TIME: 09-14-93 09:58:36
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT. 4 OPT. 1 - CURRENT COOLING METHOD
ALT. ID. A; TITLE: CUR
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		0.
ENERGY COSTS:		
ELECTRICITY	69094110.	
DISTILLATE OIL	20909170.	
PRUCHASED WINTER STEAM	79467200.	
PURCHASED SUMMER STEAM	17975140.	
TOTAL ENERGY COSTS		187445600.
ROUTINE M&R/CUSTODIAL COSTS		0.
MAJOR REPAIR/REPLACEMENT COSTS		58217.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		187503800.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 09-14-93 09:58:36
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT. 4 OPT. 1 - CURRENT COOLING METHOD
ALT. ID. A; TITLE: CUR
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 0.

BENEFICIAL OCCUPANCY DATE: JAN95
ANNUAL PAYMENTS OCCUR: JUL95 THROUGH JUL19

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	3901788.	959064.	3645011.	1015067.	0.	0.
2	3759110.	955200.	3630325.	977949.	0.	0.
3	3620968.	955713.	3632275.	942011.	0.	0.
4	3503981.	955669.	3632107.	911576.	0.	0.
5	3399009.	956717.	3636089.	884267.	0.	0.
6	3330610.	957100.	3637545.	866473.	0.	0.
7	3251647.	951416.	3615941.	845931.	0.	0.
8	3165274.	940990.	3576319.	823460.	0.	0.
9	3078696.	927086.	3523474.	800936.	0.	0.
10	2992138.	910092.	3458889.	778418.	0.	0.
11	2915658.	892359.	3391491.	758521.	0.	0.
12	2821678.	872738.	3316921.	734072.	0.	0.
13	2731420.	852681.	3240693.	710591.	0.	0.
14	2641456.	832875.	3165416.	687186.	0.	0.
15	2553949.	814181.	3094370.	664421.	0.	0.
16	2474300.	792707.	3012756.	643700.	0.	0.
17	2394895.	774600.	2943938.	623042.	0.	0.
18	2316894.	758012.	2880891.	602750.	0.	24653.
19	2241503.	741554.	2818344.	583137.	0.	21550.
20	2168631.	725238.	2756334.	564179.	0.	0.
21	2098202.	709082.	2694931.	545856.	0.	0.
22	2030124.	693094.	2634167.	528146.	0.	0.
23	1964309.	677289.	2574096.	511024.	0.	12014.
24	1900069.	660375.	2509813.	494311.	0.	0.
25	1837798.	643337.	2445059.	478111.	0.	0.
***	********	********	********	********	0.	58217.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLL

LCCID 1.072 DATE/TIME: 09-14-93 10:03:18
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT. 4 OPT. 2 - ABS. CHILLING OF E3510 &E3516
ALT. ID. B; TITLE: ABS
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 93
MIDPOINT OF CONSTRUCTION (MPC)	JAN 94
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 95
ANALYSIS END DATE (AED)	JAN 20

COST / BENEFIT DESCRIPTION	COST IN DOS \$ (\$ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	272342.0	.00	JAN 94
ELECTRICITY	4100199.0	.84	JUL95-JUL19
ELECT DEMAND	.0	.00	JUL95-JUL19
DISTILLATE OIL	989689.5	2.66	JUL95-JUL19
WINTER STEAM	3755379.0	2.66	JUL95-JUL19
SUMMER STEAM	1073254.0	.84	JUL95-JUL19

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	\$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	272801.0	.0	JAN95-JAN20
DIST	4.78	207048.0		JAN95-JAN20
WSTM	8.60	436672.0		JAN95-JAN20
SSTM	8.60	124797.0		JAN95-JAN20

LCCID 1.072 DATE/TIME: 09-14-93 10:03:18
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT. 4 OPT. 2 - ABS. CHILLING OF E3510 &E3516
ALT. ID. B; TITLE: ABS
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		268805.
ENERGY COSTS:		
ELECTRICITY	68787500.	
DISTILLATE OIL	20955630.	
PURCHASED WINTER STEAM	79516180.	
PURCHASED SUMMER STEAM	18005580.	
TOTAL ENERGY COSTS		187264900.
ROUTINE M&R/CUSTODIAL COSTS		0.
MAJOR REPAIR/REPLACEMENT COSTS		0.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		187533700.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 09-14-93 10:03:18
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT. 4 OPT. 2 - ABS. CHILLING OF E3510 &E3516
ALT. ID. B; TITLE: ABS
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 268805.

BENEFICIAL OCCUPANCY DATE: JAN95
ANNUAL PAYMENTS OCCUR: JUL95 THROUGH JUL19

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	3884473.	961195.	3647258.	1016786.	0.	0.
2	3742428.	957323.	3632563.	979605.	0.	0.
3	3604899.	957837.	3634514.	943606.	0.	0.
4	3488431.	957792.	3634346.	913120.	0.	0.
5	3383925.	958843.	3638330.	885765.	0.	0.
6	3315829.	959227.	3639788.	867940.	0.	0.
7	3237218.	953529.	3618170.	847363.	0.	0.
8	3151227.	943081.	3578524.	824855.	0.	0.
9	3065034.	929146.	3525646.	802293.	0.	0.
10	2978860.	912115.	3461021.	779736.	0.	0.
11	2902720.	894342.	3393582.	759806.	0.	0.
12	2809157.	874677.	3318966.	735315.	0.	0.
13	2719299.	854576.	3242690.	711795.	0.	0.
14	2629734.	834725.	3167367.	688350.	0.	0.
15	2542615.	815990.	3096278.	665546.	0.	0.
16	2463320.	794469.	3014613.	644790.	0.	0.
17	2384267.	776321.	2945753.	624098.	0.	0.
18	2306612.	759696.	2882667.	603771.	0.	0.
19	2231556.	743202.	2820081.	584124.	0.	0.
20	2159007.	726850.	2758033.	565134.	0.	0.
21	2088891.	710658.	2696592.	546781.	0.	0.
22	2021115.	694634.	2635791.	529040.	0.	0.
23	1955592.	678793.	2575683.	511889.	0.	0.
24	1891637.	661842.	2511360.	495149.	0.	0.
25	1829643.	644766.	2446567.	478921.	0.	0.
***	********	********	********	********	0.	0.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLL

LCCID 1.072 DATE/TIME: 09-14-93 11:06:53
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT. 5 OPT 1 - CURRENT COOLING OF E3081 & E3100
ALT. ID. B; TITLE: CUR
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 93
MIDPOINT OF CONSTRUCTION (MPC)	JAN 94
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 95
ANALYSIS END DATE (AED)	JAN 20

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JAN 94
ELECTRICITY	4118476.0	.84	JUL95-JUL19
ELECT DEMAND	.0	.00	JUL95-JUL19
DISTILLATE OIL	987495.4	2.66	JUL95-JUL19
WINTER STEAM	3753066.0	2.66	JUL95-JUL19
SUMMER STEAM	1071440.0	.84	JUL95-JUL19
CENTF CHILL (350-1)	130750.0	*******	JAN98-JAN98
CENTF CHILL (350-2)	130750.0	*******	JAN98-JAN98
CENTF CHILL (150-1)	94000.0	*******	JAN98-JAN98
CENTF CHILL (150-2)	94000.0	*******	JAN98-JAN98
CENTF CHILL (350-3)	130750.0	*******	JAN09-JAN09
CENTF CHILL (350-4)	130750.0	*******	JAN09-JAN09
CENTF CHILL (250-1)	111250.0	*******	JAN09-JAN09
CENTF CHILL (250-2)	111250.0	*******	JAN09-JAN09

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	274017.0	.0	JAN95-JAN20
DIST	4.78	206589.0		JAN95-JAN20
WSTM	8.60	436403.0		JAN95-JAN20
SSTM	8.60	124586.0		JAN95-JAN20

LCCID 1.072 DATE/TIME: 09-14-93 11:06:53
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 1 - CURRENT COOLING OF E3081 & E3100
ALT. ID. B; TITLE: CUR
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		0.
ENERGY COSTS:		
ELECTRICITY	69094110.	
DISTILLATE OIL	20909170.	
PURCHASED WINTER STEAM	79467200.	
PURCHASED SUMMER STEAM	17975140.	
TOTAL ENERGY COSTS		187445600.
ROUTINE M&R/CUSTODIAL COSTS		0.
MAJOR REPAIR/REPLACEMENT COSTS		644501.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		188090100.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 09-14-93 11:06:53
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 1 - CURRENT COOLING OF E3081 & E3100
ALT. ID. B; TITLE: CUR
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 0.

BENEFICIAL OCCUPANCY DATE: JAN95
ANNUAL PAYMENTS OCCUR: JUL95 THROUGH JUL19

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	3901788.	959064.	3645011.	1015067.	0.	0.
2	3759110.	955200.	3630325.	977949.	0.	0.
3	3620968.	955713.	3632275.	942011.	0.	0.
4	3503981.	955669.	3632107.	911576.	0.	379244.
5	3399009.	956717.	3636089.	884267.	0.	0.
6	3330610.	957100.	3637545.	866473.	0.	0.
7	3251647.	951416.	3615941.	845931.	0.	0.
8	3165274.	940990.	3576319.	823460.	0.	0.
9	3078696.	927086.	3523474.	800936.	0.	0.
10	2992138.	910093.	3458889.	778418.	0.	0.
11	2915658.	892359.	3391491.	758521.	0.	0.
12	2821678.	872738.	3316922.	734072.	0.	0.
13	2731420.	852681.	3240693.	710591.	0.	0.
14	2641456.	832875.	3165416.	687186.	0.	0.
15	2553949.	814181.	3094370.	664421.	0.	265257.
16	2474300.	792707.	3012756.	643700.	0.	0.
17	2394895.	774600.	2943939.	623042.	0.	0.
18	2316894.	758012.	2880892.	602750.	0.	0.
19	2241503.	741554.	2818344.	583137.	0.	0.
20	2168631.	725238.	2756334.	564179.	0.	0.
21	2098202.	709082.	2694931.	545856.	0.	0.
22	2030124.	693094.	2634167.	528146.	0.	0.
23	1964309.	677289.	2574097.	511024.	0.	0.
24	1900069.	660375.	2509813.	494311.	0.	0.
25	1837798.	643337.	2445060.	478111.	0.	0.
***	********	********	********	********	0.	644501.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLL

LCCID 1.072 DATE/TIME: 09-14-93 10:27:41
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 2 - ABS. CHILLING OF E3081 & E3100
ALT. ID. A; TITLE: ABS
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 93
MIDPOINT OF CONSTRUCTION (MPC)	JAN 94
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 95
ANALYSIS END DATE (AED)	JAN 20

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	1325933.0	.00	JAN 94
ELECTRICITY	3926843.0	.84	JUL95-JUL19
ELECT DEMAND	.0	.00	JUL95-JUL19
DISTILLATE OIL	2053976.0	2.66	JUL95-JUL19
WINTER STEAM	3823818.0	2.66	JUL95-JUL19
SUMMER STEAM	1157904.0	.84	JUL95-JUL19

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	261267.0	.0	JAN95-JAN20
DIST	4.78	429702.0		JAN95-JAN20
WSTM	8.60	444630.0		JAN95-JAN20
SSTM	8.60	134640.0		JAN95-JAN20

LCCID 1.072 DATE/TIME: 09-14-93 10:27:41
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 2 - ABS. CHILLING OF E3081 & E3100
ALT. ID. A; TITLE: ABS
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		1308711.
ENERGY COSTS:		
ELECTRICITY	65879160.	
DISTILLATE OIL	43490750.	
PURCHASED WINTER STEAM	80965300.	
PURCHASED SUMMER STEAM	19425720.	
TOTAL ENERGY COSTS		209760900.
ROUTINE M&R/CUSTODIAL COSTS		0.
MAJOR REPAIR/REPLACEMENT COSTS		0.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		211069600.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 09-14-93 10:27:41
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 2 - ABS. CHILLING OF E3081 & E3100
ALT. ID. A; TITLE: ABS
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 1308711.

BENEFICIAL OCCUPANCY DATE: JAN95
ANNUAL PAYMENTS OCCUR: JUL95 THROUGH JUL19

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	3720238.	1994840.	3713727.	1096983.	0.	0.
2	3584198.	1986802.	3698764.	1056869.	0.	0.
3	3452484.	1987869.	3700750.	1018030.	0.	0.
4	3340941.	1987777.	3700579.	985140.	0.	0.
5	3240853.	1989957.	3704636.	955627.	0.	0.
6	3175637.	1990754.	3706120.	936397.	0.	0.
7	3100348.	1978930.	3684108.	914196.	0.	0.
8	3017994.	1957246.	3643739.	889913.	0.	0.
9	2935444.	1928325.	3589898.	865571.	0.	0.
10	2852914.	1892979.	3524095.	841236.	0.	0.
11	2779993.	1856093.	3455427.	819734.	0.	0.
12	2690386.	1815283.	3379451.	793311.	0.	0.
13	2604327.	1773564.	3301786.	767935.	0.	0.
14	2518549.	1732367.	3225090.	742642.	0.	0.
15	2435114.	1693485.	3152705.	718039.	0.	0.
16	2359171.	1648819.	3069552.	695646.	0.	0.
17	2283460.	1611157.	2999437.	673322.	0.	0.
18	2209089.	1576652.	2935201.	651392.	0.	0.
19	2137206.	1542422.	2871475.	630196.	0.	0.
20	2067724.	1508485.	2808296.	609708.	0.	0.
21	2000572.	1474880.	2745735.	589907.	0.	0.
22	1935662.	1441625.	2683826.	570767.	0.	0.
23	1872910.	1408750.	2622623.	552263.	0.	0.
24	1811659.	1373569.	2557128.	534202.	0.	0.
25	1752286.	1338131.	2491153.	516695.	0.	0.
***	********	********	********	********	0.	0.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLL

LCCID 1.072 DATE/TIME: 09-15-93 13:46:45
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 3 - CENTRF CHILLING OF TOX LAB
ALT. ID. B; TITLE: CENT
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 93
MIDPOINT OF CONSTRUCTION (MPC)	JAN 94
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 95
ANALYSIS END DATE (AED)	JAN 20

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	581986.0	.00	JAN 94
ELECTRICITY	4385920.0	.84	JUL95-JUL19
ELECT DEMAND	.0	.00	JUL95-JUL19
DISTILLATE OIL	987495.4	2.66	JUL95-JUL19
WINTER STEAM	3753066.0	2.66	JUL95-JUL19
SUMMER STEAM	1071440.0	.84	JUL95-JUL19

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	291811.0	.0	JAN95-JAN20
DIST	4.78	206589.0		JAN95-JAN20
WSTM	8.60	436403.0		JAN95-JAN20
SSTM	8.60	124586.0		JAN95-JAN20

LCCID 1.072 DATE/TIME: 09-15-93 13:46:45
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 3 - CENTRF CHILLING OF TOX LAB
ALT. ID. B; TITLE: CENT
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		574427.
ENERGY COSTS:		
ELECTRICITY	73580910.	
DISTILLATE OIL	20909170.	
PURCHASED WINTER STEAM	79467200.	
PURCHASED SUMMER STEAM	17975140.	
TOTAL ENERGY COSTS		191932400.
ROUTINE M&R/CUSTODIAL COSTS		0.
MAJOR REPAIR/REPLACEMENT COSTS		0.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		192506800.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 09-15-93 13:46:45
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 3 - CENTRF CHILLING OF TOX LAB
ALT. ID. B; TITLE: CENT
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 574427.

BENEFICIAL OCCUPANCY DATE: JAN95
ANNUAL PAYMENTS OCCUR: JUL95 THROUGH JUL19

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	4155160.	959064.	3645011.	1015067.	0.	0.
2	4003217.	955200.	3630325.	977949.	0.	0.
3	3856105.	955713.	3632275.	942011.	0.	0.
4	3731521.	955669.	3632107.	911576.	0.	0.
5	3619732.	956717.	3636089.	884267.	0.	0.
6	3546891.	957100.	3637545.	866473.	0.	0.
7	3462802.	951416.	3615941.	845931.	0.	0.
8	3370819.	940990.	3576319.	823460.	0.	0.
9	3278619.	927086.	3523474.	800936.	0.	0.
10	3186441.	910093.	3458889.	778418.	0.	0.
11	3104994.	892359.	3391491.	758521.	0.	0.
12	3004911.	872738.	3316922.	734072.	0.	0.
13	2908792.	852681.	3240693.	710591.	0.	0.
14	2812986.	832875.	3165416.	687186.	0.	0.
15	2719796.	814181.	3094370.	664421.	0.	0.
16	2634975.	792707.	3012756.	643700.	0.	0.
17	2550413.	774600.	2943939.	623042.	0.	0.
18	2467347.	758012.	2880892.	602750.	0.	0.
19	2387060.	741554.	2818344.	583137.	0.	0.
20	2309456.	725238.	2756334.	564179.	0.	0.
21	2234454.	709082.	2694931.	545856.	0.	0.
22	2161955.	693094.	2634167.	528146.	0.	0.
23	2091867.	677289.	2574097.	511024.	0.	0.
24	2023455.	660375.	2509813.	494311.	0.	0.
25	1957141.	643337.	2445060.	478111.	0.	0.
***	********	********	********	********	0.	0.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLL

LCCID 1.072   DATE/TIME: 09-15-93 13:52:45
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 4 - ABS. CHILLING OF TOX LAB
ALT. ID. B; TITLE: ABS
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 93
MIDPOINT OF CONSTRUCTION (MPC)	JAN 94
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 95
ANALYSIS END DATE (AED)	JAN 20

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	658658.0	.00	JAN 94
ELECTRICITY	4185705.0	.84	JUL95-JUL19
ELECT DEMAND	.0	.00	JUL95-JUL19
DISTILLATE OIL	1394775.0	2.66	JUL95-JUL19
WINTER STEAM	3802645.0	2.66	JUL95-JUL19
SUMMER STEAM	1135149.0	.84	JUL95-JUL19

OTHER KEY INPUT DATA

LOCATION - MARYLAND   CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs			ELECTRIC DEMAND: 10**0 DOLLARS	
ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	278490.0	.0	JAN95-JAN20
DIST	4.78	291794.0		JAN95-JAN20
WSTM	8.60	442168.0		JAN95-JAN20
SSTM	8.60	131994.0		JAN95-JAN20

LCCID 1.072 DATE/TIME: 09-15-93 13:52:45
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 4 - ABS. CHILLING OF TOX LAB
ALT. ID. B; TITLE: ABS
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		650103.
ENERGY COSTS:		
ELECTRICITY	70221990.	
DISTILLATE OIL	29532890.	
PURCHASED WINTER STEAM	80516980.	
PURCHASED SUMMER STEAM	19043950.	
TOTAL ENERGY COSTS		199315800.
ROUTINE M&R/CUSTODIAL COSTS		0.
MAJOR REPAIR/REPLACEMENT COSTS		0.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		199965900.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 09-15-93 13:52:45
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD AREA MARYLAND
DESIGN FEATURE: ALT 5 OPT 4 - ABS. CHILLING OF TOX LAB
ALT. ID. B; TITLE: ABS
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 650103.

BENEFICIAL OCCUPANCY DATE: JAN95
ANNUAL PAYMENTS OCCUR: JUL95 THROUGH JUL19

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	3965480.	1354618.	3693163.	1075424.	0.	0.
2	3820472.	1349161.	3678283.	1036099.	0.	0.
3	3680076.	1349885.	3680258.	998024.	0.	0.
4	3561179.	1349823.	3680088.	965779.	0.	0.
5	3454494.	1351303.	3684123.	936847.	0.	0.
6	3384978.	1351844.	3685598.	917994.	0.	0.
7	3304727.	1343815.	3663708.	896230.	0.	0.
8	3216943.	1329090.	3623563.	872424.	0.	0.
9	3128952.	1309451.	3570020.	848561.	0.	0.
10	3040982.	1285449.	3504582.	824704.	0.	0.
11	2963253.	1260401.	3436294.	803624.	0.	0.
12	2867739.	1232688.	3360739.	777721.	0.	0.
13	2776007.	1204359.	3283503.	752843.	0.	0.
14	2684575.	1176383.	3207232.	728047.	0.	0.
15	2595639.	1149980.	3135248.	703928.	0.	0.
16	2514690.	1119650.	3052556.	681975.	0.	0.
17	2433988.	1094074.	2982829.	660089.	0.	0.
18	2354714.	1070644.	2918949.	638590.	0.	0.
19	2278092.	1047399.	2855575.	617811.	0.	0.
20	2204031.	1024354.	2792746.	597725.	0.	0.
21	2132452.	1001534.	2730532.	578314.	0.	0.
22	2063263.	978952.	2668965.	559550.	0.	0.
23	1996374.	956628.	2608101.	541410.	0.	0.
24	1931085.	932738.	2542969.	523704.	0.	0.
25	1867798.	908673.	2477359.	506540.	0.	0.
***	********	********	********	********	0.	0.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLL

LCCID 1.072 DATE/TIME: 01-10-94 12:16:52
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 6 OPT 1 NEW PLANT
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JUL 93
MIDPOINT OF CONSTRUCTION (MPC)	OCT 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	12275590.0	.00	OCT 93
ELECTRICITY	32795.5	.84	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
DISTILLATE OIL	844903.3	2.66	JUL94-JUL18
WINTER STEAM	3758080.0	2.66	JUL94-JUL18
SUMMER STEAM	1076841.0	.84	JUL94-JUL18
MAINT LABOR	637939.0	.00	JUL94-JUL18
MAINT SERV	32770.0	.00	JUL94-JUL18
MAINT SUPPLY	10115.0	.00	JUL94-JUL18
MAINT UTIL	150511.0	.00	JUL94-JUL18
BLR LAYAWAY	2030.0	.00	JUL94-JUL18
PERMIT & TESTING	30000.0	*******	JAN97-JAN18
BOILER MAINT	130179.0	*******	JAN09-JAN09
STACK MAINT	6941.0	*******	JAN04-JAN14
WATER TREAT. MAINT	49333.0	*******	JAN04-JAN14
FEEDWATER PUMP MAINT	16538.0	*******	JAN09-JAN09
OIL PUMP MAINT	7283.0	*******	JAN99-JAN19
ECONOMIZER	255000.0	.00	JAN 15
OIL UNLD PUMP	14544.0	.00	JAN 15
SZSOFT	109629.0	.00	JAN 15

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LCCID  1.072                    DATE/TIME:  01-10-94  12:16:52
PROJECT NO., FY, & TITLE: 1   FY 1993    ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL    MARYLAND
DESIGN FEATURE: ALT 6 OPT 1  NEW PLANT
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: T.M.
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BASIC INPUT DATA SUMMARY

OTHER KEY INPUT DATA

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LOCATION   - MARYLAND                CENSUS REGION:  3
RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 92
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ENERGY USAGE: 10**6 BTUs   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	2182.0	.0	JAN94-JAN19
DIST	4.78	176758.0		JAN94-JAN19
WSTM	8.60	436986.0		JAN94-JAN19
SSTM	8.60	125214.0		JAN94-JAN19

LCCID 1.072 DATE/TIME: 01-10-94 12:16:52
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 6 OPT 1 NEW PLANT
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		12155810.
ENERGY COSTS:		
ELECTRICITY	562902.	
DISTILLATE OIL	18027010.	
PURCHASED WINTER STEAM	80183070.	
PURCHASED SUMMER STEAM	18482900.	
TOTAL ENERGY COSTS		117255900.
ROUTINE M&R/CUSTODIAL COSTS		13018890.
MAJOR REPAIR/REPLACEMENT COSTS		469793.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		142900400.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 01-10-94 12:16:52
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 6 OPT 1 NEW PLANT
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: ********

BENEFICIAL OCCUPANCY DATE: JAN94
ANNUAL PAYMENTS OCCUR: JUL94 THROUGH JUL18

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	31791.	824954.	3669346.	1043875.	801313.	0.
2	30812.	814074.	3620951.	1011703.	770493.	0.
3	29685.	810794.	3606362.	974707.	740859.	0.
4	28594.	811229.	3608299.	938888.	712364.	26152.
5	27670.	811192.	3608133.	908555.	684965.	0.
6	26841.	812081.	3612088.	881336.	658620.	5870.
7	26301.	812406.	3613534.	863601.	633289.	23249.
8	25678.	807581.	3592072.	843126.	608932.	0.
9	24996.	798732.	3552713.	820730.	585511.	0.
10	24312.	786930.	3500216.	798281.	562992.	20668.
11	23628.	772505.	3436058.	775838.	541338.	42103.
12	23024.	757453.	3369105.	756007.	520517.	0.
13	22282.	740798.	3295027.	731639.	500497.	18374.
14	21569.	723774.	3219302.	708235.	481248.	0.
15	20859.	706961.	3144522.	684909.	462738.	0.
16	20168.	691094.	3073945.	662219.	444940.	100185.
17	19539.	672867.	2992870.	641566.	427827.	0.
18	18912.	657497.	2924507.	620977.	411372.	0.
19	18296.	643416.	2861876.	600752.	395550.	14521.
20	17701.	629447.	2799742.	581204.	380337.	0.
21	17125.	615597.	2738141.	562309.	365709.	28443.
22	16569.	601884.	2677143.	544047.	351643.	176072.
23	16031.	588313.	2616780.	526395.	338118.	0.
24	15512.	574897.	2557106.	509330.	325114.	0.
25	15004.	560540.	2493248.	492673.	312609.	11476.
***	562902.	********	********	********	********	469793.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLL

LCCID 1.072 DATE/TIME: 01-10-94 12:18:58
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 6 OPT 2 EXIST. PLANT
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JUL 93
MIDPOINT OF CONSTRUCTION (MPC)	OCT 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	6152758.0	.00	OCT 93
ELECTRICITY	32795.5	.84	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
DISTILLATE OIL	844903.3	2.66	JUL94-JUL18
WINTER STEAM	3758080.0	2.66	JUL94-JUL18
SUMMER STEAM	1076841.0	.84	JUL94-JUL18
MAINT LABOR	637939.0	.00	JUL94-JUL18
MAINT SERV	32770.0	.00	JUL94-JUL18
MAINT SUPPLY	10115.0	.00	JUL94-JUL18
MAINT UTIL	150511.0	.00	JUL94-JUL18
BLR LAYAWAY	2030.0	.00	JUL94-JUL18
PERMIT & TESTING	30000.0	*******	JAN97-JAN18
BOILER MAINT	130179.0	*******	JAN09-JAN09
STACK MAINT	13882.0	*******	JAN04-JAN14
WATER TREAT MAINT	49333.0	*******	JAN04-JAN14
FEEDWATER PUMP MAINT	16538.0	*******	JAN09-JAN09
OIL PUMP MAINT	7238.0	*******	JAN99-JAN19
OIL UNLD PUMP	14544.0	.00	JAN 15
ECONOMIZER	170000.0	.00	JAN 15
ECONOMIZER	49875.0	.00	JAN 07
RELVALVE	1577.0	.00	JAN 07
RELVALVE	1985.0	.00	JAN 07

PUMPSIMPLEX	6000.0	.00	JAN 08
PUMPSIMPLEX	9000.0	.00	JAN 12
PUMPSIMPLEX	3000.0	.00	JAN 07
TANKSTEEL	1000.0	.00	JAN 08
TANKSTEEL	1500.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 07
CONDPUMP	12500.0	.00	JAN 12
CONDREC	14000.0	.00	JAN 13
PUMP	9000.0	.00	JAN 08
FLASHTANK	380.0	.00	JAN 12
HEATEXCH	1750.0	.00	JAN 15
SZSOFT	109629.0	.00	JAN 15

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	2182.0	.0	JAN94-JAN19
DIST	4.78	176758.0		JAN94-JAN19
WSTM	8.60	436986.0		JAN94-JAN19
SSTM	8.60	125214.0		JAN94-JAN19

LCCID 1.072 DATE/TIME: 01-10-94 12:18:58
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 6 OPT 2 EXIST. PLANT
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		6092724.
ENERGY COSTS:		
ELECTRICITY	562902.	
DISTILLATE OIL	18027010.	
PURCHASED WINTER STEAM	80183070.	
PURCHASED SUMMER STEAM	18482900.	
TOTAL ENERGY COSTS		117255900.
ROUTINE M&R/CUSTODIAL COSTS		13333100.
MAJOR REPAIR/REPLACEMENT COSTS		187763.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		136869500.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 01-10-94 12:18:58
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 6 OPT 2 EXIST. PLANT
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 6092724.

BENEFICIAL OCCUPANCY DATE: JAN94
ANNUAL PAYMENTS OCCUR: JUL94 THROUGH JUL18

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	31791.	824954.	3669346.	1043875.	801313.	0.
2	30812.	814074.	3620951.	1011703.	770493.	0.
3	29685.	810794.	3606362.	974707.	740859.	0.
4	28594.	811229.	3608299.	938888.	738516.	0.
5	27670.	811192.	3608133.	908555.	684965.	0.
6	26841.	812081.	3612088.	881336.	664454.	0.
7	26301.	812406.	3613534.	863601.	656538.	0.
8	25678.	807581.	3592072.	843126.	608932.	0.
9	24996.	798732.	3552713.	820730.	585511.	0.
10	24312.	786930.	3500216.	798281.	583660.	0.
11	23628.	772505.	3436058.	775838.	588009.	0.
12	23024.	757453.	3369105.	756007.	520517.	0.
13	22282.	740798.	3295027.	731639.	518871.	0.
14	21569.	723774.	3219302.	708235.	481248.	33531.
15	20859.	706961.	3144522.	684909.	462738.	9060.
16	20168.	691094.	3073945.	662219.	545100.	0.
17	19539.	672867.	2992870.	641566.	427827.	0.
18	18912.	657497.	2924507.	620977.	411372.	0.
19	18296.	643416.	2861876.	600752.	410072.	11317.
20	17701.	629447.	2799742.	581204.	380337.	6516.
21	17125.	615597.	2738141.	562309.	397238.	0.
22	16569.	601884.	2677143.	544047.	364552.	127339.
23	16031.	588313.	2616780.	526395.	338118.	0.
24	15512.	574897.	2557106.	509330.	325114.	0.
25	15004.	560540.	2493248.	492673.	324086.	0.
***	562902.	********	********	********	********	187763.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOL

LCCID 1.072 DATE/TIME: 01-10-94 12:35:20
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 6 OPT 3 CONS. E5126 & E4000 AREA
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JUL 93
MIDPOINT OF CONSTRUCTION (MPC)	OCT 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	4348062.0	.00	OCT 93
ELECTRICITY	32795.5	.84	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
DISTILLATE OIL	863956.4	2.66	JUL94-JUL18
WINTER STEAM	3758080.0	2.66	JUL94-JUL18
SUMMER STEAM	1076841.0	.84	JUL94-JUL18
MAINT LABOR	787939.0	.00	JUL94-JUL18
MAINT SERV	39545.0	.00	JUL94-JUL18
MAINT SUPPLY	16115.0	.00	JUL94-JUL18
MAINT UTIL	150000.0	.00	JUL94-JUL18
PERMIT & TESTING	60000.0	*******	JAN97-JAN18
BOILER MAINT	303751.0	*******	JAN04-JAN19
STACK MAINT	13882.0	*******	JAN04-JAN14
WATER TREAT. MAINT	40000.0	*******	JAN04-JAN14
FEEDWATER PUMP MAINT	21025.0	*******	JAN09-JAN09
OIL PUMP MAINT	18138.0	*******	JAN99-JAN19
BREECH	27750.0	.00	JAN 15
STACK	10713.0	.00	JAN 15
DRUMCTL	15000.0	.00	JAN 08
DRUMCTL	10000.0	.00	JAN 95
FTBOILER	1450000.0	.00	JAN 00
FTBOILER	2306250.0	.00	JAN 13

FTBURNER	175500.0	.00	JAN 13
FW_REG	1400.0	.00	JAN 15
RELVALVE	16200.0	.00	JAN 08
RELVALVE	10800.0	.00	JAN 95
PUMPSIMPLEX	9000.0	.00	JAN 95
TANKSTEEL	3000.0	.00	JAN 95
BOILMASTER	15000.0	.00	JAN 18
BOILMASTER	10000.0	.00	JAN 05
FLOWMETER	3100.0	.00	JAN 05
PSIGCTRL	2600.0	.00	JAN 05
PSIGSENSOR	1100.0	.00	JAN 05
TEMPREC	3100.0	.00	JAN 05
CONDPUMP	14000.0	.00	JAN 12
CONDREC	27000.0	.00	JAN 05
DAIRHEATER	25000.0	.00	JAN 19
DAIRHEATER	31000.0	.00	JAN 17
FEEDPUMP	20000.0	.00	JAN 13
FEEDPUMP	20900.0	.00	JAN 13
OILPIPEBELOW	6500.0	.00	JAN 93
PUMP	22500.0	.00	JAN 00
TANKABOVE	83000.0	.00	JAN 93
UNLOADPUMP	9434.0	.00	JAN 93
SZSOFT	115500.0	.00	JAN 04
ECONOMIZER	42500.0	.00	JAN 15
ECONOMIZER	49875.0	.00	JAN 07
RELVALVE	3562.0	.00	JAN 07
PUMPSIMPLEX	6000.0	.00	JAN 08
PUMPSIMPLEX	9000.0	.00	JAN 12
PUMPSIMPLEX	3000.0	.00	JAN 07
SZSOFT	48963.0	.00	JAN 15
FLASHTANK	380.0	.00	JAN 12
PUMP	9000.0	.00	JAN 08

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	2182.0	.0	JAN94-JAN19
DIST	4.78	180744.0		JAN94-JAN19
WSTM	8.60	436986.0		JAN94-JAN19
SSTM	8.60	125214.0		JAN94-JAN19

LCCID 1.072 DATE/TIME: 01-10-94 12:35:20
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 6 OPT 3 CONS. E5126 & E4000 AREA
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		4305637.
ENERGY COSTS:		
ELECTRICITY	562902.	
DISTILLATE OIL	18433530.	
PURCHASED WINTER STEAM	80183070.	
PURCHASED SUMMER STEAM	18482900.	
TOTAL ENERGY COSTS		117662400.
ROUTINE M&R/CUSTODIAL COSTS		15522080.
MAJOR REPAIR/REPLACEMENT COSTS		3329920.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		140820000.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 01-10-94 12:35:20
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 6 OPT 3 CONS. E5126 & E4000 AREA
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 4305637.

BENEFICIAL OCCUPANCY DATE: JAN94
ANNUAL PAYMENTS OCCUR: JUL94 THROUGH JUL18

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	31791.	843557.	3669346.	1043875.	955384.	0.
2	30812.	832431.	3620951.	1011703.	918638.	30926.
3	29685.	829077.	3606362.	974707.	883306.	0.
4	28594.	829523.	3608299.	938888.	849333.	52304.
5	27670.	829485.	3608133.	908555.	816666.	0.
6	26841.	830394.	3612088.	881336.	785256.	14619.
7	26301.	830726.	3613534.	863601.	755054.	1187637.
8	25678.	825792.	3592072.	843126.	726013.	0.
9	24996.	816744.	3552713.	820730.	698090.	0.
10	24312.	804675.	3500216.	798281.	671240.	41337.
11	23628.	789926.	3436058.	775838.	645423.	325440.
12	23024.	774534.	3369105.	756007.	620599.	29874.
13	22282.	757504.	3295027.	731639.	596730.	36748.
14	21569.	740095.	3219302.	708235.	573779.	33236.
15	20859.	722904.	3144522.	684909.	551710.	26161.
16	20168.	706679.	3073945.	662219.	530491.	53992.
17	19539.	688040.	2992870.	641566.	510087.	0.
18	18912.	672324.	2924507.	620977.	490468.	0.
19	18296.	657925.	2861876.	600752.	471604.	40359.
20	17701.	643641.	2799742.	581204.	453466.	1174105.
21	17125.	629479.	2738141.	562309.	436025.	32231.
22	16569.	615457.	2677143.	544047.	419254.	82330.
23	16031.	601580.	2616780.	526395.	403129.	0.
24	15512.	587861.	2557106.	509330.	387624.	12333.
25	15004.	573180.	2493248.	492673.	372716.	28691.
***	562902.	********	********	********	********	3329920.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLL

LCCID 1.072 DATE/TIME: 12-17-93 14:00:07
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 7 (15% COND. LEAK)
ALT. ID. A; TITLE: REP
NAME OF DESIGNER: TM

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 93
MIDPOINT OF CONSTRUCTION (MPC)	JAN 94
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 95
ANALYSIS END DATE (AED)	JAN 20

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	270063.0	.00	JAN 94
DISTILLATE OIL	-6333.5	-.85	JUL95-JUL19
WATER COST	-3231.0	.00	JUL95-JUL19
CHEMICAL COSTS	-118.5	.00	JUL95-JUL19

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	4.78	-1325.0		JAN95-JAN20

LCCID 1.072 DATE/TIME: 12-17-93 14:00:07
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 7 (15% COND. LEAK)
ALT. ID. A; TITLE: REP
NAME OF DESIGNER: TM

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		266555.
ENERGY COSTS:		
DISTILLATE OIL	-134104.	
TOTAL ENERGY COSTS		-134104.
ROUTINE M&R/CUSTODIAL COSTS		-50644.
MAJOR REPAIR/REPLACEMENT COSTS		0.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		81807.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 12-17-93 14:00:07
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: ALT 7 (15% COND. LEAK)
ALT. ID. A; TITLE: REP
NAME OF DESIGNER: TM

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 266555.

BENEFICIAL OCCUPANCY DATE: JAN95
ANNUAL PAYMENTS OCCUR: JUL95 THROUGH JUL19

PAY	DIST	OPER'NL	CAPITAL
1	-6151.	-3117.	0.
2	-6126.	-2997.	0.
3	-6130.	-2882.	0.
4	-6129.	-2771.	0.
5	-6136.	-2665.	0.
6	-6139.	-2562.	0.
7	-6102.	-2463.	0.
8	-6035.	-2369.	0.
9	-5946.	-2278.	0.
10	-5837.	-2190.	0.
11	-5723.	-2106.	0.
12	-5597.	-2025.	0.
13	-5469.	-1947.	0.
14	-5342.	-1872.	0.
15	-5222.	-1800.	0.
16	-5084.	-1731.	0.
17	-4968.	-1664.	0.
18	-4862.	-1600.	0.
19	-4756.	-1539.	0.
20	-4651.	-1480.	0.
21	-4548.	-1423.	0.
22	-4445.	-1368.	0.
23	-4344.	-1315.	0.
24	-4235.	-1265.	0.
25	-4126.	-1216.	0.
***	-134105.	-50644.	0.

*NET PW EQUIVALENTS ON SEP93; IN 10**0 DOLLARS; IN CONSTANT SEP93 DOLL

LCCID 1.072 DATE/TIME: 01-07-94 10:34:30
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: COMB. OF ALT4 OPT 2 & ALT 6 OPT 2
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.0%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JUL 93
MIDPOINT OF CONSTRUCTION (MPC)	OCT 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	6425100.0	.00	OCT 93
ELECTRICITY	43391.6	.84	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
DISTILLATE OIL	848832.4	2.66	JUL94-JUL18
WINTER STEAM	3758080.0	2.66	JUL94-JUL18
SUMMER STEAM	1085415.0	.84	JUL94-JUL18
MAINT LABOR	637939.0	.00	JUL94-JUL18
MAINT SERV	32770.0	.00	JUL94-JUL18
MAINT SUPPLY	10115.0	.00	JUL94-JUL18
MAINT UTIL	150511.0	.00	JUL94-JUL18
BLR LAYAWAY	2030.0	.00	JUL94-JUL18
PERMIT & TESTING	30000.0	*******	JAN97-JAN18
BOILER MAINT	130179.0	*******	JAN09-JAN09
STACK MAINT	13882.0	*******	JAN04-JAN14
WATER TREAT MAINT	49333.0	*******	JAN04-JAN14
FEEDWATER PUMP MAINT	16538.0	*******	JAN09-JAN09
OIL PUMP MAINT	7238.0	*******	JAN99-JAN19
OIL UNLD PUMP	14544.0	.00	JAN 15
ECONOMIZER	170000.0	.00	JAN 15
ECONOMIZER	49875.0	.00	JAN 07
RELVALVE	1577.0	.00	JAN 07
RELVALVE	1985.0	.00	JAN 07

PUMPSIMPLEX	6000.0	.00	JAN 08
PUMPSIMPLEX	9000.0	.00	JAN 12
PUMPSIMPLEX	3000.0	.00	JAN 07
TANKSTEEL	1000.0	.00	JAN 08
TANKSTEEL	1500.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 07
CONDPUMP	12500.0	.00	JAN 12
CONDREC	14000.0	.00	JAN 13
PUMP	9000.0	.00	JAN 08
FLASHTANK	380.0	.00	JAN 12
HEATEXCH	1750.0	.00	JAN 15
SZSOFT	109629.0	.00	JAN 15

OTHER KEY INPUT DATA

LOCATION - MARYLAND CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 92

ENERGY USAGE: 10**6 BTUs ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	15.03	2887.0	.0	JAN94-JAN19
DIST	4.78	177580.0		JAN94-JAN19
WSTM	8.60	436986.0		JAN94-JAN19
SSTM	8.60	126211.0		JAN94-JAN19

```
LCCID  1.072                    DATE/TIME:  01-07-94  10:34:30
PROJECT NO., FY, & TITLE: 1   FY 1993    ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL    MARYLAND
DESIGN FEATURE: COMB. OF ALT4 OPT 2 & ALT 6 OPT 2
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: T.M.
```

LIFE CYCLE COST TOTALS*

CONSTRUCTION/ACQUISITION COSTS		6362409.
ENERGY COSTS:		
ELECTRICITY	744774.	
DISTILLATE OIL	18110840.	
PURCHASED WINTER STEAM	80183070.	
PURCHASED SUMMER STEAM	18630070.	
TOTAL ENERGY COSTS		117668800.
ROUTINE M&R/CUSTODIAL COSTS		13333100.
MAJOR REPAIR/REPLACEMENT COSTS		187763.
OTHER COSTS & MONETARY BENEFITS:		
OTHER PRE-OCCUPANCY COSTS/BENEFITS	0.	
NET DISPOSAL COSTS OR RETENTION VALUE	0.	
OTHER CAPITAL COSTS/BENEFITS	0.	
OTHER OPERATIONAL COSTS/BENEFITS	0.	
TOTAL OTHER COSTS & MONETARY BENEFITS		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		137552000.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLLA
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 92

LCCID 1.072 DATE/TIME: 01-07-94 10:34:30
PROJECT NO., FY, & TITLE: 1 FY 1993 ABERDEEN PROVING GROUNDS
INSTALLATION & LOCATION: EDGEWOOD ARSENAL MARYLAND
DESIGN FEATURE: COMB. OF ALT4 OPT 2 & ALT 6 OPT 2
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: T.M.

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

PRE-OCCUPANCY COSTS:

CONSTRUCTION/ACQUISITION: 6362409.

BENEFICIAL OCCUPANCY DATE: JAN94
ANNUAL PAYMENTS OCCUR: JUL94 THROUGH JUL18

PAY	ELECT	DIST	WSTM	SSTM	OPER'NL	CAPITAL
1	42063.	828790.	3669346.	1052187.	801313.	0.
2	40767.	817859.	3620951.	1019758.	770493.	0.
3	39276.	814564.	3606362.	982468.	740859.	0.
4	37833.	815002.	3608299.	946364.	738516.	0.
5	36610.	814964.	3608133.	915789.	684965.	0.
6	35514.	815857.	3612088.	888354.	664454.	0.
7	34799.	816184.	3613534.	870477.	656538.	0.
8	33974.	811337.	3592072.	849840.	608932.	0.
9	33072.	802446.	3552713.	827265.	585511.	0.
10	32167.	790589.	3500216.	804638.	583660.	0.
11	31263.	776098.	3436058.	782015.	588009.	0.
12	30464.	760975.	3369105.	762027.	520517.	0.
13	29482.	744243.	3295027.	737464.	518871.	0.
14	28539.	727139.	3219302.	713875.	481248.	33531.
15	27599.	710249.	3144522.	690362.	462738.	9060.
16	26684.	694308.	3073945.	667491.	545100.	0.
17	25852.	675996.	2992870.	646675.	427827.	0.
18	25022.	660554.	2924507.	625922.	411372.	0.
19	24207.	646408.	2861876.	605536.	410072.	11317.
20	23420.	632374.	2799742.	585832.	380337.	6516.
21	22658.	618460.	2738141.	566786.	397238.	0.
22	21923.	604683.	2677143.	548379.	364552.	127339.
23	21211.	591049.	2616780.	530586.	338118.	0.
24	20524.	577570.	2557106.	513385.	325114.	0.
25	19852.	563146.	2493248.	496596.	324086.	0.
***	744774.	********	********	********	********	187763.

*NET PW EQUIVALENTS ON JUL93; IN 10**0 DOLLARS; IN CONSTANT JUL93 DOLL

ALT. 4 OPT. 2
ABSORPTION CHILLING OF E3510 & E3516

ITEM DESCRIPTION	QUANTITY		COST	
	NO. UNITS	UNITS	$/UNIT	TOTAL
250 TON ABSORPTION WATE CHILLER (SINGLE STAGE)	1			$115,000
COOLING TOWER (840 GPM)	1			$31,184
COOLING WATER PUMP (15	1			$7,111
CHILLED WATER PUMP (15 H	1			$7,111
CHILLED WATER PIPE (4")	1150	LF.	$38.60	$44,390
CONDENSOR PIPE (6")	50	LF.	$30.47	$1,524

			SUB TOTAL	$206,320
			OVRHD (10	$20,632
			CNTGCY (10	$20,632
			DESIGN (6%	$12,379
			SIOH (6%)	$12,379
			TOTAL COS	$272,342

ALT. 5 OPT 2
ABSORPTION CHILLING OF E3081 & E3100

ITEM DESCRIPTION	QUANTITY		COST	
	NO. UNITS	UNITS	$/UNIT	TOTAL
1200 TON ABSORPTION WAT CHILLER (SINGLE STAGE)	1			$307,000
1000 TON ABSORPTION WAT CHILLER (SINGLE STAGE)	1			$282,000
COOLING TOWER (7500 GPM, 2 CELLS)	1			$241,015
COOLING WATER PUMP 115	1			$27,000
COOLING WATER PUMP 100	1			$25,000
CHILLED WATER PUMP 40 H	1			$9,800
CHILLED WATER PUMP 50 H	1			$10,300
CHILLED WATER PIPE (6")	500	LF.	$55.15	$27,575
CHILLED WATER PIPE (8")	1000	LF.	$67.73	$67,730
CONDENSOR PIPE (12")	50	LF.	$60.89	$3,045
CONDENSOR PIPE (14")	50	LF.	$80.60	$4,030

			SUB TOTAL	$1,004,495
			OVRHD (10	$100,449
			CNTGCY (10	$100,449
			DESIGN (6%	$60,270
			SIOH (6%)	$60,270
			TOTAL COS	$1,325,933

ALT. 5 OPT 3
CENTRIFUGAL CHILLING OF TOX LAB

ITEM DESCRIPTION	QUANTITY		COST	
	NO. UNITS	UNITS	$/UNIT	TOTAL
1100 TON CENTRIFUGAL CHILLER (SINGLE STAGE)	1			$279,667
COOLING TOWER	1			$120,508
COOLING WATER PUMP 100	1			$25,000
CHILLED WATER PUMP 25 H	1			$8,580
CHILLED WATER PIPE (8")	50	LF.	$62.27	$3,114
CONDENSOR PIPE (14")	50	LF.	$80.60	$4,030
			SUB TOTAL	$440,899
			OVRHD (10	$44,090
			CNTGCY (10	$44,090
			DESIGN (6%	$26,454
			SIOH (6%)	$26,454
			TOTAL COS	$581,986

ALT. 5 OPT 4
ABSORPTION CHILLING OF TOX LAB

ITEM DESCRIPTION	QUANTITY		COST	
	NO. UNITS	UNITS	$/UNIT	TOTAL
1100 TON ABSORPTION WAT CHILLER (SINGLE STAGE)	1			$307,000
COOLING TOWER (3700 GPM	1			$120,508
COOLING WATER PUMP 100	1			$25,000
CHILLED WATER PUMP 25 H	1			$8,580
CHILLED WATER PIPE (8")	500	LF.	$67.73	$33,865
CONDENSOR PIPE (14")	50	LF.	$80.60	$4,030
			SUB TOTAL	$498,983
			OVRHD (10	$49,898
			CNTGCY (10	$49,898
			DESIGN (6%	$29,939
			SIOH (6%)	$29,939
			TOTAL COS	$658,658

ALT 6
OPTION 2 INVESTMENT CALCULATIONS

ITEM DESCRIPTION	QUANTITY		COST	
	NO. UNITS	UNITS	$/UNIT	TOTAL
DEMO COSTS PER BOILER				

BOILER REMOVAL	1600	HOURS	$100.00	$160,000

			SUB TOTAL	$160,000
TOTAL DEMO COSTS	5	EA	$160,000.00	$800,000
NEW CONSTRUCTION				

REMOVE/REPLACE BOILER HOUSE WALL	900	SF	$25.00	$22,500
BOILER 70 MBtu/hr	3	EA	$570,000.00	$1,710,000
BOILER PIPING	1000	LF	$100.00	$100,000
BOILER VALVING	60	EA	$3,000.00	$180,000
FEEDWATER PUMP	3	EA	$13,782.00	$41,346
OIL PIPE (ABV GRND)	100	FT	$14.00	$1,400
OIL PIPE (BLW GRND)	100	FT	$26.00	$2,600
OIL TANK (ABV GRND)	2	EA	$192,279.00	$384,558
OIL UNLOADING PUMP	2	EA	$7,272.00	$14,544
BOILER DRY LAYAWAY	10	EA	$120,670.00	$1,206,700
WATER TREATMENT SYS.	1	EA	$197,532.00	$197,532

				$3,861,180
		SUB TOTAL	OF ALL COSTS	$4,661,180
			OVRHD(10%)	$466,118
			CNTGCY (10%)	$466,118
			DESIGN (6%)	$279,671
			SIOH (6%)	$279,671
			TOTAL COST	$6,152,758

ALT 6
OPTION 3 INVESTMENT CALCULATIONS

ITEM DESCRIPTION	QUANTITY		COST	
	NO. UNITS	UNITS	$/UNIT	TOTAL
DEMO COSTS PER BOILER				

BOILER REMOVAL	1600	HOURS	$100.00	$160,000

			SUB TOTAL	$160,000
TOTAL DEMO COSTS	5	EA	$160,000.00	$800,000
NEW CONSTRUCTION				

REMOVE/REPLACE BOILER HOUSE WALL	900	SF	$25.00	$22,500
BOILER 70 MBtu/hr	2	EA	$570,000.00	$1,140,000
BOILER PIPING	500	LF	$100.00	$50,000
BOILER VALVING	40	EA	$3,000.00	$120,000
FEEDWATER PUMP	2	EA	$13,782.00	$27,564
OIL PIPE (ABV GRND)	100	FT	$14.00	$1,400
OIL PIPE (BLW GRND)	100	FT	$26.00	$2,600
OIL TANK (ABV GRND)	2	EA	$192,279.00	$384,558
OIL UNLOADING PUMP	2	EA	$7,272.00	$14,544
BOILER DRY LAYAWAY	5	EA	$120,670.00	$603,350
WATER TREATMENT SYS.	1	EA	$127,470.00	$127,470

				$2,493,986
		SUB TOTAL	OF ALL COST	$3,293,986
			OVRHD(10%)	$329,399
			CNTGCY (10	$329,399
			DESIGN (6%)	$197,639
			SIOH (6%)	$197,639
			TOTAL COST	$4,348,062

ALT. 7
REPLACE CONDENSATE LINE FROM E3312 TO E3580

ITEM DESCRIPTION	QUANTITY		COST	
	NO. UNITS	UNITS	$/UNIT	TOTAL
ASBESTOS REMOVAL				

4" OVER HEAD COND. PIPE	2488	LF	$3.93	$9,778
GLOVE BAG ELBOWS	55	EA	$56.78	$3,123
PIPE DEMOLITION				

4" OVER HEAD PIPE	2488	LF	$2.00	$4,976
PIPE INSTALLATION				

6" OVER HEAD PIPE	2488	LF	$58.77	$146,220
ELBOWS	55	EA	$335.00	$18,425
JOINT WELDING	124	EA	$178.00	$22,072

			SUB TOTAL	$204,594
			OVRHD (10	$20,459
			CNTGCY (10	$20,459
			DESIGN (6%	$12,276
			SIOH (6%)	$12,276
			TOTAL COS	$270,063

Appendix E: Aberdeen Proving Ground Heating and Cooling Degree Days

ACTUAL HDD FOR BALTIMORE/WASH INTL, MD
BASED ON 65 DEG F

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1950	0	0	0	0	0	0	0	0	65	167	510	931	1673
1951	810	751	619	311	86	9	0	0	27	157	619	754	4143
1952	771	713	674	258	80	0	0	0	18	299	485	790	4088
1953	739	622	562	299	23	13	0	0	38	178	509	747	3729
1954	915	621	621	222	159	7	0	0	21	214	590	871	4241
1955	963	814	538	215	62	22	0	0	22	173	589	983	4381
1956	946	696	695	377	119	12	0	2	78	168	493	582	4167
1957	988	667	628	256	80	4	0	0	45	303	446	733	4151
1958	957	970	741	284	84	12	0	0	39	210	447	1008	4753
1959	965	768	618	227	55	11	0	0	40	219	544	770	4218
1960	855	778	947	221	121	2	0	0	13	214	457	1059	4668
1961	1109	741	562	430	162	7	0	0	27	198	474	916	4626
1962	932	679	696	337	68	0	0	0	83	202	654	1080	4929
1963	1133	1012	541	313	124	2	0	1	96	151	451	1072	4897
1964	916	869	569	378	85	17	0	2	36	310	397	762	4341
1973	881	884	526	313	173	4	0	0	15	184	430	813	4223
1974	814	822	559	288	128	7	0	0	37	265	450	726	4096
1975	775	700	666	403	71	3	0	0	42	120	366	795	3940
1976	1022	569	457	268	101	11	0	1	25	337	651	946	4386
1977	1212	747	439	224	51	16	0	0	6	213	428	826	4161
1978	1061	1017	666	269	114	12	1	0	21	223	411	683	4479
1979	925	1064	483	311	59	5	3	1	19	266	361	724	4222
1980	911	911	671	253	56	6	0	0	14	263	569	828	4482
1981	1083	679	662	190	118	0	0	0	41	312	492	879	4456
1982	1153	781	647	384	43	12	0	1	23	255	430	636	4364
1983	895	798	551	391	112	7	0	0	56	217	499	923	4448
1984	1069	621	784	373	128	11	0	1	80	92	557	577	4293
1985	1053	695	543	222	57	8	0	0	34	162	332	903	4008
1986	901	846	555	284	60	5	0	19	25	193	549	781	4218
1987	965	825	525	324	78	1	0	0	9	358	442	731	4258
1988	1061	757	566	346	80	22	1	0	25	367	461	801	4485
1989	782	739	623	322	110	0	0	0	43	199	526	1163	4507
MEAN	923.8	761.1	591.7	290.4	89	7.8	0.2	0.9	36.3	224.7	488.1	837.3	4251.2

ACTUAL CDD FOR BALTIMORE/WASH INTL, MD
BASED ON 65 DEG F

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1950	0	0	0	0	0	0	0	318	113	28	23	0	482
1951	0	0	0	21	87	256	408	335	174	68	0	3	1352
1952	0	0	0	29	58	355	474	350	151	17	0	0	1434
1953	0	0	0	17	157	303	432	359	186	13	0	0	1468
1954	0	1	0	28	64	273	397	318	221	129	0	0	1431
1955	0	0	0	9	122	164	537	438	175	33	0	0	1479
1956	0	0	0	30	90	270	356	325	175	13	4	0	1262
1957	0	0	0	74	151	330	395	319	239	4	0	0	1513
1958	0	0	0	19	79	186	427	319	147	21	0	0	1198
1959	0	0	0	47	189	298	403	421	244	111	6	0	1719
1960	0	0	0	73	56	234	335	398	171	17	0	0	1285
1961	0	0	0	19	49	230	371	323	297	22	18	0	1329
1962	0	0	5	46	164	239	298	313	117	38	0	0	1221
1963	0	0	0	32	60	279	370	267	90	15	0	0	1113
1964	0	0	5	11	128	275	402	290	176	0	2	0	1290
1973	0	0	3	46	39	265	357	368	195	22	0	0	1296

HDD = 65 - T
CDD = T - 65

YEAR	MONTH	DAY	HDD	CDD	MONTHL TOTAL
90	1	1	25	0	
90	1	2	30	0	
90	1	3	27	0	
90	1	4	25	0	
90	1	5	21	0	
90	1	6	25	0	
90	1	7	31	0	
90	1	8	31	0	
90	1	9	28	0	
90	1	10	21	0	
90	1	11	24	0	
90	1	12	26	0	
90	1	13	34	0	
90	1	14	31	0	
90	1	15	23	0	
90	1	16	17	0	
90	1	17	13	0	
90	1	18	6	0	
90	1	19	23	0	
90	1	20	27	0	
90	1	21	16	0	
90	1	22	23	0	
90	1	23	23	0	
90	1	24	13	0	
90	1	25	13	0	
90	1	26	22	0	
90	1	27	27	0	
90	1	28	18	0	
90	1	29	21	0	
90	1	30	21	0	
90	1	31	22	0	707
90	2	1	21	0	
90	2	2	12	0	
90	2	3	20	0	
90	2	4	25	0	
90	2	5	28	0	
90	2	6	19	0	
90	2	7	17	0	
90	2	8	19	0	
90	2	9	14	0	

90	2	10	16	0	
90	2	11	28	0	
90	2	12	27	0	
90	2	13	19	0	
90	2	14	8	0	
90	2	15	21	0	
90	2	16	9	0	
90	2	17	18	0	
90	2	18	33	0	
90	2	19	15	0	
90	2	20	30	0	
90	2	21	28	0	
90	2	22	19	0	
90	2	23	10	0	
90	2	24	26	0	
90	2	25	41	0	
90	2	26	43	0	
90	2	27	37	0	
90	2	28	28	0	631
90	3	1	28	0	
90	3	2	26	0	
90	3	3	15	0	
90	3	4	31	0	
90	3	5	27	0	
90	3	6	27	0	
90	3	7	36	0	
90	3	8	32	0	
90	3	9	18	0	
90	3	10	13	0	
90	3	11	9	0	
90	3	12	0	3	
90	3	13	0	8	
90	3	14	0	3	
90	3	15	0	2	
90	3	16	0	3	
90	3	17	3	0	
90	3	18	11	0	
90	3	19	15	0	
90	3	20	27	0	
90	3	21	20	0	
90	3	22	16	0	
90	3	23	9	0	
90	3	24	27	0	
90	3	25	26	0	
90	3	26	23	0	

90	3	27	26	0	
90	3	28	25	0	
90	3	29	20	0	
90	3	30	22	0	
90	3	31	20	0	552
90	4	1	15	0	
90	4	2	13	0	
90	4	3	17	0	
90	4	4	22	0	
90	4	5	12	0	
90	4	6	22	0	
90	4	7	25	0	
90	4	8	24	0	
90	4	9	18	0	
90	4	10	7	0	
90	4	11	13	0	
90	4	12	23	0	
90	4	13	25	0	
90	4	14	17	0	
90	4	15	8	0	
90	4	16	9	0	
90	4	17	8	0	
90	4	18	19	0	
90	4	19	18	0	
90	4	20	8	0	
90	4	21	4	0	
90	4	22	4	0	
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DAILY CDD BY MONTH FOR 90 91 FOR BALTIMORE/WASH INTL, MD

YEAR	MONTH	MAXCDD
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90	4	14
90	5	9
90	6	18
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91	11	2
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USACERL DISTRIBUTION

Chief of Engineers
ATTN: CEHEC-IM-LH (2)
ATTN: CEHEC-IM-LP (2)
ATTN: CECG
ATTN: CECC-P
ATTN: CECW
ATTN: CECW-O
ATTN: CECW-P
ATTN: CECW-PR
ATTN: CEMP
ATTN: CEMP-E
ATTN: CEMP-C
ATTN: CEMP-M
ATTN: CEMP-R
ATTN: CERD-C
ATTN: CERD-ZA
ATTN: CERD-L
ATTN: CERD-M
ATTN: CERM
ATTN: DAEN-ZC
ATTN: DAIM-FDP

CECPW 22310-3862
ATTN: CECPW-E

US Army Engr District
ATTN: Library (40)

INSCOM
ATTN: IALOG-I 22060
ATTN: IAV-DPW 22186

USA TACOM 48397-5000
ATTN: AMSTA-XE

US Army Materiel Command (AMC)
Alexandria, VA 22333-0001
ATTN: AMCEN-F
Installations: (19)

FORSCOM
Forts Gillem & McPherson 30330
ATTN: FCEN
Installations: (23)

TRADOC
Fort Monroe 23651
ATTN: ATBO-G
Installations: (20)

Fort Belvoir 22060
ATTN: Engr Strategic Studies Ctr
ATTN: Australian Liaison Office

CEWES 39180
ATTN: Library

CECRL 03755
ATTN: Library

USA AMCOM
ATTN: Facilities Engr 21719
ATTN: AMSMC-EH 61299
ATTN: Facilities Engr (3) 85613

USAARMC 40121
ATTN: ATZIC-EHA

Military Dist of WASH
Fort McNair
ATTN: ANEN 20319

USA Engr Activity, Capital Area
ATTN: Library 22211

Engr Societies Library
ATTN: Acquisitions 10017

Defense Logistics Agency
ATTN: DLA-WI 22304

National Guard Bureau 20310
ATTN: NGB-ARI

Naval Facilities Engr Command
ATTN: Facilities Engr Command (8)
ATTN: Public Works Center (8)

Tyndall AFB 32403
ATTN: HQAFCESA Program Ofc
ATTN: Engrg & Srvc Lab

US Army Envr Hygiene Agency
ATTN: HSHB-ME 21010

US Army Aberdeen Proving Ground
ATTN: APGSA/STEAP-FE-PE (14)

US Gov't Printing Office 20401
ATTN: Rec Sec/Deposit Sec (2)

Nat'l Institute of Standards & Tech
ATTN: Library 20899

Defense Tech Info Center 22304
ATTN: DTIC-FAB (2)

184
11/95